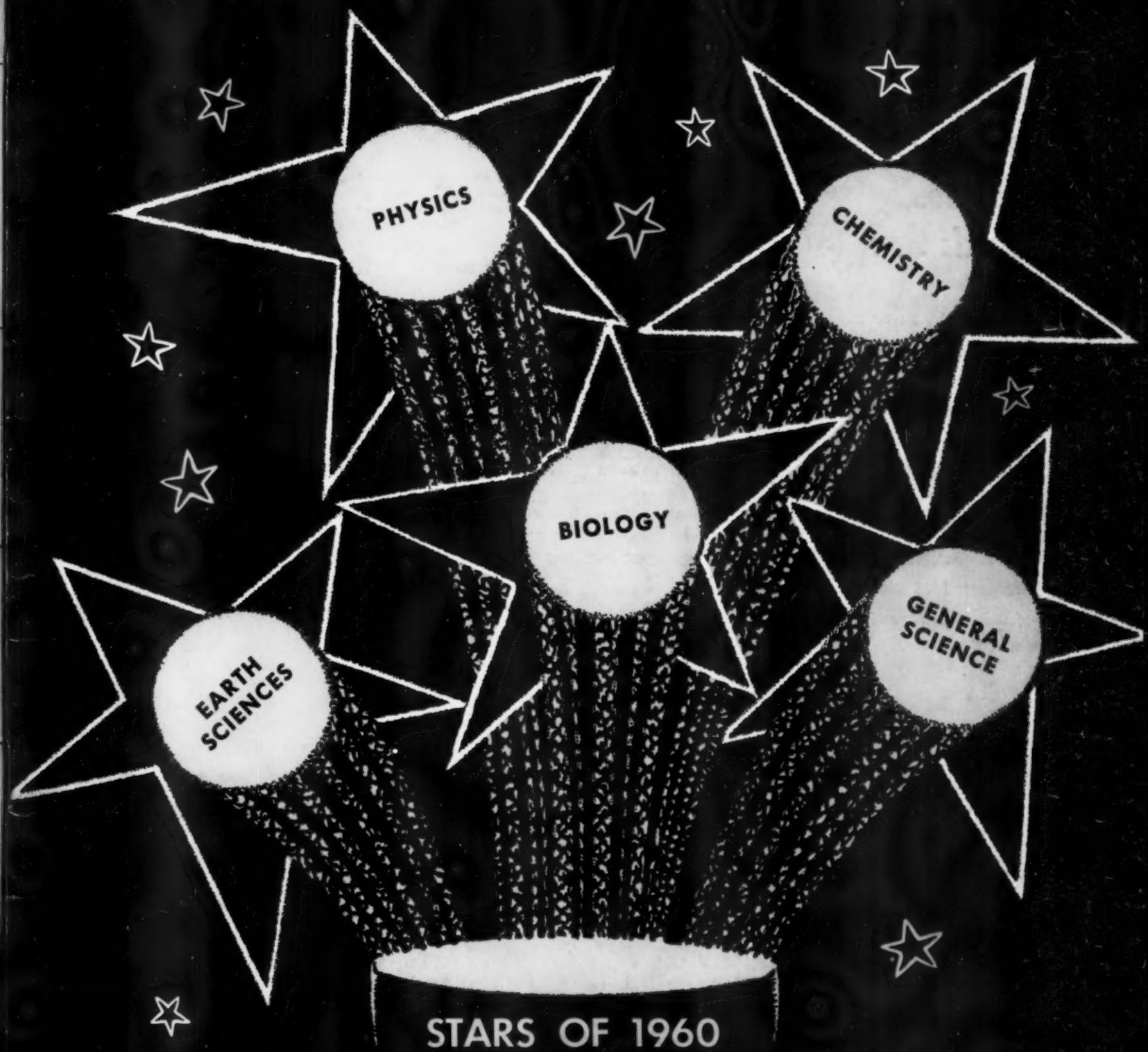


THE SCIENCE TEACHER

VOLUME 27, NUMBER 3 • APRIL 1960



**for
answers
to your
textbook
needs . . .**

we invite you to consider the Harcourt, Brace science textbooks and to compare them with other available publications. We feel you will find convincing evidence that the Harcourt, Brace program, now quite prominent, is deservedly respected in the field of junior and senior high school science.

**HARCOURT, New York
BRACE AND Chicago
COMPANY Dallas
Burlingame**

HARCOURT, BRACE SCIENCE PROGRAM



*Under the General Editorship
of PAUL F. BRANDWEIN*

GENERAL SCIENCE

YOU AND YOUR WORLD

Discoveries in Science (Workbook) • Teacher's Manual • Teaching Tests

YOU AND YOUR RESOURCES

Explorations in Science (Workbook) • Teacher's Manual • Teaching Tests

YOU AND SCIENCE

Experiences in Science (Workbook) • Teacher's Manual • Teaching Tests, Forms A and B • *Harbrace Science Filmstrips*

SCIENCE FOR BETTER LIVING: COMPLETE COURSE

Teaching Tests • Workbook

THE BIOLOGICAL SCIENCES

EXPLORING BIOLOGY: THE SCIENCE OF LIVING THINGS

Experiences in Biology (Workbook plus Laboratory Manual) • Teacher's Manual • Teaching Tests, Forms A and B • *Harbrace Biology Filmcharts*

YOUR BIOLOGY

Teacher's Manual (Including Unit Tests)

YOUR HEALTH AND SAFETY

Teacher's Manual • Teaching Tests

LIFE GOES ON

THE SCIENTISTS SPEAK: BIOLOGY (a long-play record)

THE PHYSICAL SCIENCES

THE PHYSICAL WORLD: A COURSE IN PHYSICAL SCIENCE

Teacher's Manual • Teaching Tests

EXPLORING CHEMISTRY (In Preparation)

Laboratory Manual in Chemistry • *Experiences in Chemistry* (Workbook plus Laboratory Manual) • Teacher's Manual • Teaching Tests

EXPLORING PHYSICS

Laboratory Manual in Physics • *Experiences in Physics* (Workbook plus Laboratory Manual) • Teaching Tests, Forms A and B

A SPECIAL BOOK FOR THE STUDENT

HOW TO DO AN EXPERIMENT

BOOKS FOR THE TEACHER

TEACHING HIGH SCHOOL SCIENCE: A BOOK OF METHODS

TEACHING HIGH SCHOOL SCIENCE: A SOURCEBOOK FOR THE BIOLOGICAL SCIENCES

TEACHING HIGH SCHOOL SCIENCE: A SOURCEBOOK FOR THE PHYSICAL SCIENCES (In Preparation)

THE GIFTED STUDENT AS FUTURE SCIENTIST

You Can Depend on the GENATRON

● The MODERN Electrostatic Generator

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendously high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting the GENATRON cracks into action at the snap of the switch—whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

An Output of 250,000 Volts—or More!

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

Modern Design—Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old-fashioned static machine!

NO FRAGILE PARTS—Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

NO TRANSFER BODIES—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disks or segments—each of which inevitably permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established *directly upon the discharge terminal*. The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

Unique Features of the Cambosco Genatron

DISCHARGE TERMINAL Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

CHARGE CARRYING BELT To the terminal, charges are conveyed by an endless band of pure, live latex—a Cambosco development which has none of the shortcomings inherent in a belt with an overlap joint.

DISCHARGE BALL High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

BASE...AND DRIVING MECHANISM Stability is assured by the massive, cast metal base where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

The flat, top surface of the base (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

PRINCIPAL DIMENSIONS The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are respectively, 3 in. and 10 in. The base measures 5½ x 7 x 14 in.



GENATRON, WITH MOTOR DRIVE

Operates on 110-volt A.C. or 110-volt D.C. Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug, Switch, and Operating Instructions.

No. 61-705 \$98.75



GENATRON, WITH SPEED CONTROL

Includes (in addition to equipment itemized under No. 61-705) built-in Rheostat, for demonstrations requiring less than maximum output.

No. 61-708 \$109.00

No. 61-710 Endless Belt. Of pure latex. For replacement in No. 61-705 or No. 61-708 \$3.00

CAMBOSCO SCIENTIFIC COMPANY

37 ANTWERP ST. • BRIGHTON STATION • BOSTON, MASS.

30 PHYSIOLOGY, HEALTH, HYGIENE, SAFETY, AND FIRST-AID CHARTS

Over 600 Illustrations in Color

Charts 1-21 edited by Dr. A. J. Carlson

Charts 22-30 edited by Dr. Carl A. Johnson,
Northwestern Univ., Amer. Red Cross and Nat'l Safety Council Facilities



The charts are available in the following three mountings:

No. 7050	Charts with tripod	Set, \$37.50
No. 7050A	Charts with wall bracket	Set, \$37.50
No. 7050B	Charts with round steel base on rollers	Set, \$47.50

COMPLETELY UP-TO-DATE

Original method of presentation with
interest, as primary motive.

Not Technical—body functions and proper
body care is underlying theme.

Self-teaching—brief explanations on each
chart explain drawings without need of
reference to texts.

Color differentiation clarifies body pro-
cesses as well as emphasizing most important
facts.

VISUAL EDUCATION AT ITS BEST

More than 600 illustrations.

Large size—29 x 42 inches, yet convenient
to handle.

Equivalent to 900 pages of an average
text.

Always available for student or teacher
reference.

Consolidates material of all modern ele-
mentary texts.

Unique organization of material makes
learning easy.

TEACHER'S MANUAL of 128 pages out-
lining eighty experiments is provided with the
charts, and includes much new factual material
not previously available. Physiology can now
be a laboratory study or teacher's demonstration
course instead of only a text book course.

Produced by most modern lithographic equip-
ment.

Indispensable to teaching young people the
important facts about their body and its care.

W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

ESTABLISHED 1880

1515 Sedgwick Street, Dept. T, Chicago 10, Illinois, U. S. A.

Manufacturers of Scientific Instruments and Laboratory Apparatus

THE SCIENCE TEACHER

STAFF

Editor	ROBERT H. CARLETON
Associate Editor and Advertising	FRANCES J. LANER
Staff Assistants	JACQUELYN A. FISH S. JUSTINE BURTON
Circulation and Subscriptions	GEORGE A. CROSBY
Memberships	EDITH M. LANGLEY

ADVISORY BOARD

RICHARD SALINGER (1960) <i>Chairman</i> Wilton High School, Wilton, Connecticut
ALFRED B. BUTLER (1961) Washington State University Pullman, Washington
MILDRED EINZIG (1961) Cleveland Public Schools Cleveland, Ohio
HOWARD P. MCCOLLUM (1962) State Department of Education Baton Rouge, Louisiana
JAMES A. RUTLEDGE (1962) University of Nebraska Lincoln, Nebraska
DOROTHY VAUGHN (1960) Neodesha High School Neodesha, Kansas

SCIENCE CONSULTANTS

WILLIAM JONES BOWEN, National Institutes of Health, <i>Biology</i>
LEO SCHUBERT, American University, <i>Chemistry</i>
JOHN S. TOLL, University of Maryland, <i>Physics</i>

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association

Volume 27, Number 3 • April 1960

STARS OF 1960

- An NSTA Staff Report 6

RESEARCH FOR HIGH SCHOOL SCIENCE TEACHERS

- Donald A. Schaefer 14

CHROMATOGRAPHY OF INORGANIC IONS

- Arnold E. Bereit 20

ONE APPROACH TO SCIENCE SUPERVISION

- Alan Mandell 25

TEACHING, TESTING, AND CONSERVATION

- Sidney L. Belt 29

THE BIOLOGICAL SCIENCES CURRICULUM STUDY, AMERICAN

- INSTITUTE OF BIOLOGICAL SCIENCES 41

THE ELEMENTARY SCHOOL SCIENCE REPORTER

- Supervision of Elementary School

- Science: In-Service Courses

- Harold E. Tannenbaum 50

CLASSROOM IDEAS

- Cyclosis and Plasmolysis

- Frank E. Wolf 36

- Quantitative Analysis

- Richard B. Kent 37

SCIENCE TEACHING MATERIALS

- Book Briefs 57

- Professional Reading 59

- Audio-Visual Aids 63

EDITORIAL 4

LETTERS 5

NSTA ACTIVITIES 53

FSA ACTIVITIES 55

NSTA CALENDAR 63

INDEX OF ADVERTISERS 64

Editorial

We have been reporting periodically on special current programs in science curriculum development. As other programs develop and the information is made available to us, reports will be included in *TST*.

Many persons have expressed divergent views on the relative merits of these special programs, and in our society, this is as it should be. For many schools and teachers, however, the question is how do, or how should these curriculum developments affect us? What things should we consider before we either accept or reject one of the new curricula?

The products of the current curriculum projects should not be considered as the answer to the many problems in current science education. There are certain schools where the "new" course in physics would be completely out of place; there are other schools where every physics student should be enrolled in this course. If you accept that the curriculum might not be the correct "prescription" for all students, the first evaluative criterion that must be used is "objectivity." The curriculum should be objectively evaluated against the needs of the students. Teachers teach subject matters, true, but they teach it to students. If the subject matter and the students are incompatible, one or the other must be changed, and the boys and girls are enrolled in your school because they and their tax-paying parents live in the community.

Don't treat the new curriculum as a "sacred package." If the whole "curriculum package" is not suitable for your particular situation, perhaps part of it is. Use the course unit by unit and only those units that fit your students' needs. How many of you change the chapter order of, skip content in, or add to the content of the textbook you are currently using? Why should you feel any differently about the curriculum materials presently under development?

Some persons have voiced the objection that to do this changes the objectives of the course. Perhaps it does, and perhaps for your students the objectives of the course as it is developed need changing. You are using the curriculum in your classroom and not conducting it for the people who developed it. There is nothing that leads us to suspect that some curricula have a certain validity index and that by changing the content we change the validity. Even if there were, changing the curriculum to suit your needs will probably, for your purpose, increase this validity.

So far you have been advised to be cautious in considering a "new" curriculum. You should, however, also be open-minded. Since the development of these curricula was largely done by persons other than high school teachers, some teachers may conclude that these curricula are not for their students. Science teachers drawing such a conclusion without more data or evidence are arriving at an unscientific judgment.

Teachers using and evaluating new curricular ideas in the classroom are as true experimentalists as are any other research workers. All teachers wish to instill the spirit of the scientific process in their students. When students observe their teachers using the scientific process in evaluating a curriculum, this is setting an excellent example, and much effective learning can come about through example.

JOHN W. RENNER
Associate Executive Secretary

THE SCIENCE TEACHER

The Journal of the National Science Teachers Association, published by the Association monthly except January, June, July, and August. Editorial and executive offices, 1201 Sixteenth Street, N.W., Washington 6, D.C. Of the membership dues (see listing below) \$3 is for the Journal subscription. Single copies, \$1.00. Copyright, 1960 by the National Science Teachers Association. Second-class postage paid at Washington, D.C. Printing and typography by Judd & Detweiler, Inc., Washington, D.C.

Articles published in *The Science Teacher* are the expressions of the writers. They do not, however, necessarily represent the policy of the Association or the Magazine Advisory Board.

OFFICERS OF THE ASSOCIATION

DONALD G. DECKER, President, Colorado State College, Greeley, Colorado

ROBERT A. RICE, President-elect, Berkeley High School, Berkeley, California

HERBERT A. SMITH, Retiring President, University of Kansas, Lawrence, Kansas

SYLVIA NEIVERT, Secretary, Bay Ridge High School, Brooklyn, New York

J. DONALD HENDERSON, Treasurer, University of North Dakota, Grand Forks, North Dakota

ROBERT H. CARLETON, Executive Secretary, 1201 Sixteenth Street, N.W., Washington 6, D.C.

MEMBERSHIP

The membership year extends for one year from date of enrollment. Subscriptions are entered for either the calendar year or the school year.

Regular Membership	\$ 6.00
Sustaining Membership *	10.00
Student (college and university) Membership	2.00
Life Membership *	175.00
Payable in ten annual installments; \$150 if paid in three years or less.	
Library Subscriptions *	8.00

* Includes the *Elementary School Science Bulletin* published monthly from September through April of each year.



Stereoscopic and Widefield Microscope

Can Be Your Greatest Classroom Help

Swift Stereoscopic and Widefield Microscope is truly an outstanding instrument for classroom use. Deep, erect, three-dimensional image that is right-side-up, gives the added advantage of no inverted image. Long working distance with splendid field of view 10mm at 20 power. Can be elevated to examine large Botanical specimens, or used over a culture dish. The stage is large and very useful. This Swift model is a must for every Science classroom.

Model SBW-1, vertical binocular body with interpupillary adjustment and diopter adjusting scale on right eyepiece tube, to correct for any difference between operator's eyes. Built in 2x objective, Widefield eyepieces 10x, 15x; power range 20x-30x. All optics are Swift Rubycoated to obtain best possible resolution. Stable, well-balanced stand with opaque center plate which is removable; large, durable stage clips. Instrument can be elevated on standard. Modern sand finish. Complete in wooden cabinet with lock and key.

Only **109.80** in lots of
5 or more

122.00 each.



SWIFT INSTRUMENTS, Inc.

1572 N. FOURTH STREET • SAN JOSE, CALIFORNIA

Letters

I have just completed reading the September 1959 issue of *The Science Teacher*. It's a wonderful and inspiring publication. I didn't know that I was missing such a wealth of information until I read it.

If it is at all possible, will you please send me the copies that I have missed for the school year 1959-60.

MARTHA H. WILKERSON
2755 East First Street
Fort Worth, Texas

Congratulations on the new format for *The Science Teacher*. According to my usual practice, I picked the magazine up and started flipping from the back and began to notice the change right away. Your presentation of articles and the more sprightly editorial style are quite noticeable. It is a distinct improvement, and you should benefit greatly from it.

ROBERT F. GOULD
Assistant to the Editorial
Director
American Chemical Society
Washington, D. C.

Congratulations on the February issue of *The Science Teacher*, which I have just received. The larger format is handled beautifully. It will now be the more painful for me to see issues of the journal without a Van Nostrand ad.

GEORGE W. BAUER
Advertising Department
D. Van Nostrand Company,
Inc.
Princeton, New Jersey

I like the magazine and other services received. I am placing my accumulated copies in our Ferris Institute library for the use of our prospective science teachers.

ALAN E. VAN ANTWERP
116 Rust Avenue
Big Rapids, Michigan

May I comment briefly on the new format of your magazine. Frankly, I am disappointed with the change. It seems to me that an attempt has been made to provide a magazine in the "popular style." Its larger size makes it more difficult to file on bookshelves, while in content it is full of distracting advertising scattered throughout the magazine. If only the advertising were placed at the front or the back as in most intellectual magazines the advertising would not be so objectionable. Surely the placement of the advertising distracts seriously from the usefulness of the magazine.

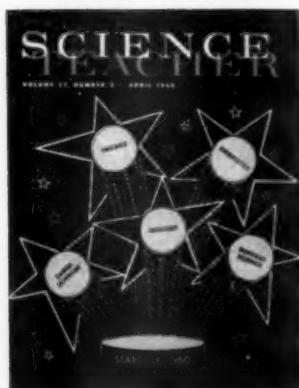
May I add that the journal of your companion association, the National Council of Teachers of Mathematics, represents my ideal of a professional magazine for teachers. Of course, I would expect more illustrations and somewhat more advertising in a science magazine than in one dealing with mathematics.

L. W. KUNELIUS
Inspector of High Schools
Government of the
Province of Alberta
Calgary, Alberta, Canada

Hearty congratulations on the great improvement in *The Science Teacher's* format and typography. Although the journal has always been my first reading love, your 1960 approach might well be said to pace many other good things which are to come in this decade.

The Association is to be complimented for such a fine job.

JAMES R. IRVING
Executive Secretary
Laboratory Equipment Section
Scientific Apparatus Makers
Association
Chicago, Illinois



THIS MONTH'S COVER . . .

Light and energy received from the stars are essentially produced as a result of a nuclear process. As the process occurs, temperatures rise to a hundred million degrees, particles in radiating streams collide at tremendous velocities, and new particles are formed. So it is with the STARS of 1960. New ideas are formed, collide, emerge, and extend to influence all areas of science teaching.



332 pages
7 x 9½ inches
Tables, drawings

For your Science Department
a wonderful new reference book
for outward-reaching young minds

Guide to the Space Age

BY C. W. BESSERER & HAZEL C. BESSERER
This book is a SIMPLIFIED thesaurus of space knowledge.

Most single-volume reference books on space count their entries in hundreds. GUIDE TO THE SPACE AGE presents over 5000! Most space books concentrate on astronomy or rockets or physics. GUIDE TO THE SPACE AGE covers the entire field.

It supplies facts for students on missiles, rockets, space flight, astronomy, meteorology, measurement, abbreviations, space jargon, et al. Each definition is as non-technical as possible, and is streamlined for easy grasp.

AUTHORITATIVE: C. W. Besserer has served in executive capacity on BUMBLEBEE, TALOS, TITAN and MINUTEMAN projects. Hazel Besserer, as Supervisor, Applied Physics Lab, Johns Hopkins U. They have standardized, systematized and alphabetized the space facts students want, made them fingertip-accessible to teachers for answering questions.

A must reference book for every Science library. See it on approval, without risk.

SEND NOW

Prentice-Hall, Inc., Englewood Cliffs, N. J.
Send me a copy of GUIDE TO THE SPACE AGE by Besserer & Besserer on approval.
At the end of ten days I'll either send \$7.95 in payment (plus a few cents for packing and shipping) or return the book and owe nothing.

Name.....

Company.....

Street.....

City, Zone, State.....

SAVE: Send payment with order and we'll prepay packing, shipping. Same return privileges, with refund.

CK-EG-12

STAR



S.R. MARY HERMIAS MENNEMEYER, S.S.N.D.

*Let those who are in
favour with their Stars
Of public honour and
proud titles boast.*

Shakespeare, Sonnet

THE winners of NSTA's 1960 Science Teacher Achievement Recognition (STAR) awards may be justly proud of the public honors accorded them at the Kansas City convention and in the press, of the \$13,500 in prize money which they pocketed, and, most of all, of the professional service they have rendered to their fellow teachers of science and their students.

It is not easy to become a STAR. Over 2500 teachers started the quest by writing in for entry forms and information. Nearly 400 carried through with submissions of reports on science teaching ideas they devised and then tested in the classroom. Two teams of judges read these reports with the utmost consideration of objectives and criteria for the program. The quality of the entries in STAR '60 was high and the competition was keen. Nevertheless, the judges came up with 56 winners of cash awards and 78 winners of meritorious citations.

The \$1000 Award

The first-place award of \$1000 went to **Sr. Mary Hermias Mennemeyer, S.S.N.D.**, teacher of chemistry and physics at St. Francis Borgia High School, Washington, Missouri. Her entry, "Adventures in Radioactivity for High School Students," included a detailed account of some 80 experiments

and projects with radioisotopes, many of them essentially of a junior research or "open-ended" laboratory activity. This project was stimulated by an Oak Ridge National Laboratory Summer Institute which Sr. Hermias attended, and was developed with the cooperation of Sr. Mary Joecile Ksycki, S.S.N.D., head of the chemistry department at nearby Notre Dame College, St. Louis, Missouri.

The STAR '60 program was designed, in part, to encourage collabora-



STARS OF 1960

An NSTA Staff Report



tion of scientists and science teachers in the development of science teaching ideas. It is noteworthy, therefore, that the top award-winning entry was a joint effort. Only seven such projects, however, were among the 56 which won cash awards, and one was among the honorable mention citations.

The \$500 Awards

Winners in the \$500 category represented a diverse array of new approaches in teaching science—ERMA, the Electronic Review Motivating Automaton; devices for air-age studies; a school planting project of a "world court of trees" with data from United Nations countries; and a study of organic coatings for metals are examples.

Winner of \$500 and also the Bausch & Lomb Microscope for the top entry in the field of biology was a collaborative project submitted by Mrs. Carolyn A. Gibson of North Hills High School, Pittsburgh, Pennsylvania. The cooperating scientist was Dr. John R. Jablonski of the University of Pittsburgh School of Medicine. This report centered on a high school student team studying various aspects of cancer. Names of the STARS of 1960 and the titles of their reports are listed on the following pages.

The STARS Themselves

Where do the STARS come from, and what kind of teachers are they? The winners of the 11 top awards included 3 from California, 2 from New York, 2 from Arizona, and 1 each from Missouri, Pennsylvania, Texas, and Ohio. When all 56 cash award winners

are considered, 25 states are included in the honor roll. Two states alone accounted for 20 of these winners—New York with 11, and California with 9; Massachusetts and Ohio came next with 3 each. Fourteen more states, bringing the grand total to 39, plus the District of Columbia and Japan, complete the roster when winners of meritorious citations are included.

Ten of the 56 entries which won cash awards were submitted by women, three of whom were Catholic Sisters. Ten of these top entries related to the junior high school level. Biology outstripped all other fields as the central discipline for the projects, there being 27 winners in this area. Physics was next with 13 successful entries, followed by chemistry with 5.

Selection of STARS

Judging and selection were rigorous but procedures were planned and directed impartially keeping the objectives and criteria as outlined in the STAR '60 brochure in sharp focus. A first-round review of all entries was conducted by a judging team comprised of 19 individuals—5 teachers from junior and senior high schools, 9 government or university scientists, and 5 persons serving in administrative posts in science education. This group narrowed the entries from nearly 400 to a selected group of 150 for final judging. Members of the National and Advisory Committees for STAR '60, augmented by four other persons, made the final choices. During these two judging operations, all papers emerging on lists as winners and meritorious citations were read and evaluated independently by

at least ten judges. Many of the 56 winners were present at the Kansas City convention to receive their checks and bronze medallions. Trophy case plaques, engraved with the names of all winners, have been sent to their respective schools.

Radiations from the STARS

There is no doubt that the influence of this STAR program, as with others in the past, will extend far beyond mere recognition of 56 science teachers. The excellent work of these teachers and of other entrants in STAR '60 will radiate to inspire and help thousands more through an NSTA publication which will present many of their science teaching ideas. Expected to be off the press early in the fall, copies of this publication will be sent free to all NSTA Life and Sustaining members and to library subscribers. Additional copies will be available to others as a sales item. Other STAR '60 reports will



be reviewed for possible publication in future issues of *The Science Teacher*.

Appreciations

On behalf of the Board of Directors and staff of NSTA, sincere thanks and appreciation for professional service are extended to all who have helped

make STAR '60 a success—the National Cancer Institute for its sponsorship and financial support; the 400 entrants who activated the program; the National and Advisory Committees who shaped the program design and supervised its course of development; the more than 20 judges who gave over

30 hours each in evaluating the entries; Mr. Robert H. Carleton, Executive Secretary of NSTA, and Dr. Abraham Raskin, Professor of Physiology at Hunter College, New York City, who have served as director and secretary-editor, respectively, for all three STAR programs of 1956, 1958, and 1960.



\$1000 AWARD

Sr. Mary Hermias Mennemeyer, S.S.N.D., St. Francis Borgia High School, Washington, Mo.; Scientist collaborator: **Sr. Mary Jocelle Ksycki, S.S.N.D.,** Notre Dame College, St. Louis, Mo. "Adventures in Radioactivity for High School Students."

\$500 AWARDS

Ira Finkel, Island Trees High School, Levittown, N. Y. "World Court of Trees."

Carolyn A. Gibson, North Hills High School, Pittsburgh, Pa.; Scientist collaborators: **John R. Jablonski** and **Joseph H. Sunder,** University of Pittsburgh, Pittsburgh, Pa. "Cancer Research Team of North Hills High School Biology Students Cooperating with the Addison M. Gibson Laboratory, School of Medicine, University of Pittsburgh, Pennsylvania."

Paul D. Merrick and **Jerrett W. Rollins,** Carlmont High School, Belmont, Calif. "Quantitative Reaction of Magnesium Ribbon with Oxygen."

Charles W. Owens, Jr., Crozier Technical High School, Dallas, Texas. "A Study of Organic Coatings."

Stanley C. Pearson, Pasadena City Schools, Pasadena, Calif. "Light Ray Tracer."

Harvey Pollack, Forest Hills High School, Forest Hills, N. Y. "ERMA (Electronic Review Motivating Automaton)."

David T. Smith, Catalina High School and Tucson District No. 1, Tucson, Ariz. "Devices for an Air Age Study."

Thomas E. Thorpe, Jr., West High School, Phoenix, Ariz. "Project Pendulum."

\$250 AWARDS

Frederick R. Avis, Saint Mark's School, Southborough, Mass. "Part I—A Presentation of Experiments for Secondary School Students in the Field of Muscle-Nerve Physiology. Part II—A Description of the Recent Addition to Our Laboratory Which Makes It Possible for the Secondary School Student to Experience Actual Advanced Laboratory Work in Several Fields of the Biological Sciences."

Marjorie P. Behringer, Alamo Heights High School, San Antonio, Texas. "A Course of Study for Advanced Biology."



JOHN R. JABLONSKI



CAROLYN A. GIBSON



JOSEPH H. SUNDER

Harry K. Wong, Menlo-Atherton High School, Atherton, Calif. "A Mathematical Approach Toward Geotropism."

S. Alton Yarian, Emerson Junior High School, Lakewood, Ohio. "Give Them a 'See'."

Richard F. Blake, Stratford High School, Stratford, Conn. "How to Teach 36 Hours a Day."

Maurice Bleifeld, Benjamin Franklin High School, New York, N. Y. "Learning About a Scientific Library."

James V. DeRose, Chester High School, Chester, Pa. "Principles of Measurement for Senior High School Students."

Harold L. Eddleman, Salem-Washington Township High School, Salem, Ind.; Scientist collaborator: **A. E. Bell**, Purdue University, Lafayette, Ind. "A Student-Teacher Research Team."

Lola Jean Eriksen, Mountain View High School, Mountain View, Calif. "Ecology: The Out-of-doors Is Our Classroom."

Robert G. Stryker, Rialto Junior High School, Rialto, Calif. "Project Solar Water Heater: A Seventh Grade Research Program."

Morris Frankston, Pacific Beach Junior High School, San Diego, Calif. "A Simplified Method of Demonstrating Sodium Ion Movement Through the Glass of an Electric Light Bulb."

Theodore J. Griffin, Sr., Opelousas High School, Opelousas, La. "Radioisotopic Experiments."

Isadore Halpern, Erasmus Hall High School, Brooklyn, N. Y. "Simplified Techniques for Studying Fruit Flies."

Thomas M. Haynes, George Washington High School, Indianapolis, Ind. "An Environmental Study Designed to Stimulate Critical Thinking in Biology."

Chester O. Hurd, Chillicothe High School, Chillicothe, Ohio. "A Method to Enhance the Study of Vectors and Motion in High School Physics."

Herman H. Kirkpatrick, Roosevelt High School, Des Moines, Iowa. "Photography in the High School Physics Laboratory."

Harold J. Levy, Sheepshead Bay High School, Brooklyn, N. Y. "A Kymograph for Less than a Dollar."

Arthur C. Murdock, Sutton High School, Sutton, Mass. "The Teaching of General Science Through Experimentation."

David E. Newton, Ottawa Hills High School, Grand Rapids, Mich. "The Skill-Centered General Science Course."

Thomas G. Overmire, Shortridge High School, Indianapolis, Ind. "Mathematics in Biology."

Margy E. Radecki, Baker High School, Columbus, Ga. "Survey of Certain Natural and Community Resources in Muscogee County that Aid in Teaching Science in High School."

Elsie S. Scott, Northfield School for Girls, East Northfield, Mass. "Relative Humidity as a Key Concept in the Understanding of Weather, Air Conditioning, and Health."

\$100 AWARDS

Flavin J. Arseneau, Arlington Heights High School, Fort Worth, Texas. "Science Stimulation Research in the High School."

Emma Wagoner Batts and Robert L. Gantert, Alexander Hamilton Junior High School, Seattle, Wash. "Introduction to Radiation Biology."

Joel Beller, Richmond Hill High School, Richmond Hill, N. Y. "Open-End Eggsperiments."

Matthew H. Bruce, Jr., DuBois Area High School, DuBois, Pa. "Using the Cathode Ray Oscilloscope in the High School."

Thomas G. Carluomagno, Fairlawn High School, Fairlawn, N. J. "The Science Work-Experience Program."

John D. Davis, Exeter High School, Exeter, N. H. "Physiological Demonstration of the Quahog Heart: Apparatus and Techniques."

Phillip R. Fordyce, Oak Park and River Forest High School, Oak Park, Ill. "Taught, Tempered, and Tested Advanced Biology."

Lester S. Hollinger, Glen Rock High School, Glen Rock, N. J. "A High School Summer Science Program."

Paul Kahn, Bronx High School of Science, Bronx, N. Y. "Advanced Placement, Research, and Microbiology."

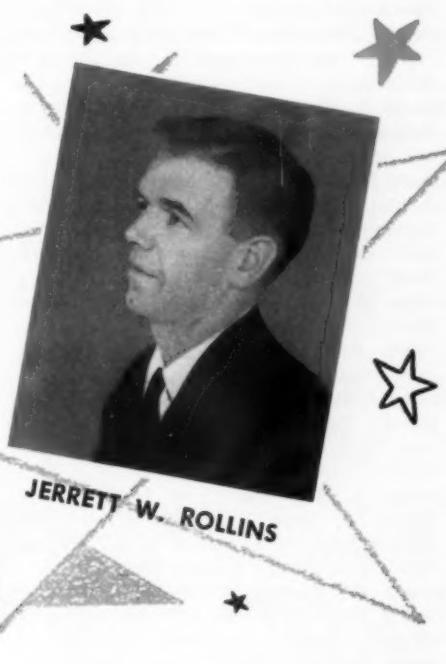
William N. Nichols, Vermont College, Montpelier, Vt. "Original and Revised Demonstrations to Illustrate Science Principles."

Doris E. Oatman, Hoover High School, San Diego, Calif. "Talented Science Students Participate in a Learning Experience and Provide a Service to Their Community."

Nellie F. Shepard, Southington High School, Southington, Conn.; Scientist collaborator: **John Bradley Bulman**, Central Connecticut State College, New Britain, Conn. "A Variation of Robert Andrews Millikan's Method for Determining the Electric Charge Carried by an Electron."

Robert W. Stegner, East High School, Denver, Colo.; Scientist collaborator: **Erik K. Bonde**, University of Colorado, Boulder, Colo. "The Regulation of Plant Growth."

Francis J. St. Lawrence, Lakewood High School, Lakewood, Calif. "The Case for the Home Laboratory."



Zachariah Subarsky, Bronx High School of Science, Bronx, N. Y. "A Biology-Biochemistry Unit in the High School Biology Course—a Teaching Project."

Katharine Tucker, Penfield Senior High School, Penfield, N. Y. "A Revitalized Approach to the Teaching of Photosynthesis."

Theodore H. Varbalow, Olney High School, Philadelphia, Pa. "The Anatomy of a Research Project."

David Webster, Lincoln Public Schools, Lincoln, Mass. "Operation Salafreeze."



Victor M. Showalter, Fairmont High School, Kettering, Ohio. "The Kettering Chemathon."

Sr. Mary Paulinus, O.P., St. Mary High School, Cheyenne, Wyo. "Research in the Hinterland."

Sr. M. Henriella Reinders, F.S.P.A., Cathedral High School, Superior, Wis.; Scientist collaborators: **Sr. M. David Campi, P.B.V.M.**, Presentation Academy, San Francisco, Calif., and **Sr. M. Ignatiana Donaghue, I.H.M.**, St. Mary Convent, Monroe, Mich. "Radiation Biology for Biology Students."

Robert L. Stanger, Long Beach High School, Long Beach, N. Y. "Aggressive Mice."

Michael J. Stimac, S.M., St. Joseph High School, Cleveland, Ohio. "Amateur Radio—Aladdin's Lamp for Teachers."

Kenneth D. Wagner, Manual Arts High School, Los Angeles, Calif. "Simplified Plastic Embedding for Teacher and Student."

Gerrit C. Zwart, Suffern High School, Suffern, N. Y. "The Graviplane."



HARVEY POLLACK

MERITORIOUS CITATIONS

Norman Abraham, Yuba City Union High School, Yuba City, Calif. "The High School Science Expedition—A 'Recipe for Research'."

Bessie S. Abramovitz, West Philadelphia High School, Philadelphia, Pa. "We've Reached the Heavens."

Ruth H. Adams, Redlands High School, Redlands, Calif. "A Field Approach to High School Biology."

Owen N. Alberty, Beaverton High School, Beaverton, Ore. "A Geology Detective Story."

John A. Banasick, Southern Regional High School, Manahawkin, N. J. "History of Science."

Robert M. Barber, Thomas Jefferson Junior High School, Eugene, Ore. "A Science Survey."

Alfred Bender, Stuyvesant High School, New York, N. Y. "The Working Classroom for the Bright Student."

Percy F. Benedict, Tilton School, Tilton, N. H. "An Approach to the Study of Physics."

Wilbert L. Braxton, William Penn Charter School, Philadelphia, Pa. "An Analysis of the Motion of a Falling Body."

Stanley R. Breckner, Southwest Junior High School, Albert Lea, Minn. "Exploratory Experiences in Ninth Grade Physical Science—A Laboratory Manual and Workbook."

Brother Wendel Adam, C.S.C., Holy Cross High School, New Orleans, La. "Moonwatch Participation by High School Science Students."

Brother Julian E. Roy, Mt. St. Michael High School, New York, N. Y. "How to Build and Demonstrate a Classroom Transmitter."

Charles A. Browning, East High School, Knoxville, Tenn. "Original Method for Determining the Duration of the Retinal Impression on the Human Eye."

Richard W. Burkey, Derby High School, Derby, Kans. "Experiment on Momentum."

William C. Carden, Mt. Miguel High School, Spring Valley, Calif. "Experimental Biology II."

George P. Carpenter, Wayland High School, Wayland, Mass. Two projects: "Course in Electronics; and Unit in Physical Chemistry."

Ernest J. Ceragioli and Paul F. Robloff, Mount Vernon School, Chicago, Ill. "Geology of Chicago Area."

Gabriel J. Damico, Smedley Junior High School, Chester, Pa. "Balloon Meteorology."

L. Dale Davison, Marion-Harding High School, Marion, Ohio. "An Optics Box."

Daniel L. Dindal, Worthington High School, Worthington, Ohio. "Ecology Studies in High School Biology."

Oliver W. Eason, Cedar Falls High School, Cedar Falls, Iowa. "Vectors in High School."

Clair W. Elmore, Santa Rosa High School, Santa Rosa, Calif. "A Periodic Table Designed for Teaching."

Max C. Epstein, New Utrecht High School, Brooklyn, N. Y. "The Chemical-Amie-Maker."

David L. Fagle, Marshalltown High School, Marshalltown, Iowa. "Bacteriology Available to Everyone."

Thaddeus B. Fowler, Point Pleasant Beach High School, Point Pleasant Beach, N. J. "The Use of Automatic Demonstrations in the Science Classroom."

Robert L. Gantert, Alexander Hamilton Junior High School, Seattle, Wash. "Strange as It Seems in Biology."

Jeanne L. Gelber, Robert E. Lee High School, Baytown, Texas. "The Teacher, a Catalyst in the Development of Youthful Scientists."

Harvey J. Goehring, Jr., Penn Hills Senior High School, Pittsburgh, Pa. "The Development of Critical Thinking in the Physics Laboratory."



STANLEY C. PEARSON

Norman N. Goldstein, Jr., Sir Francis Drake High School, San Anselmo, Calif. "Use of the Tape Recorder as a Technique for the Improvement of Learning and Teaching."

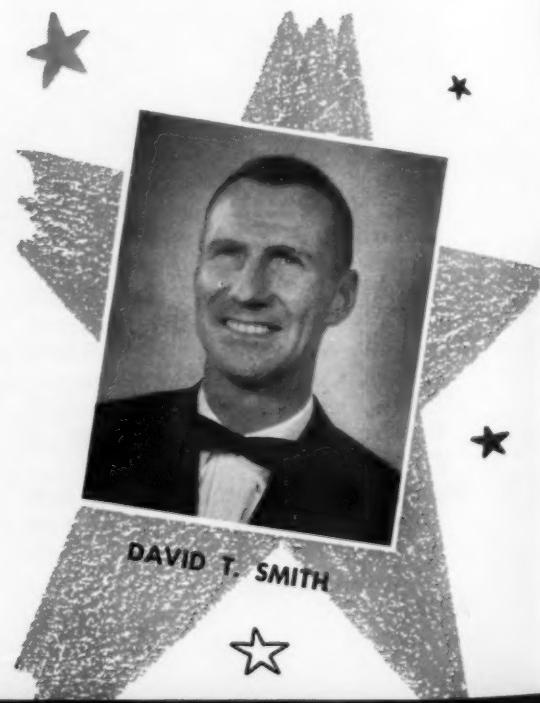
Meyer L. Gottlieb, De Witt Clinton High School, Bronx, N. Y.; Scientist collaborator: **George S. Snell**, Roscoe B. Jackson Laboratory, Bar Harbor, Maine. "An Integrated Year-round Pupil-Teacher-Scientist Program in Experimental Biology."

William S. Green, North High School, Denver, Colo., and **Eugene H. Herrington**, Palmer School, Denver, Colo. "BG' Science Wheel."

Richard W. Guyer, Thomas Carr Howe High School, Indianapolis, Ind. "Let's Integrate the Yards-Park Program into the Biology Curriculum."

Doris E. Hadary, North Bethesda Junior High School, Bethesda, Md. "Ninth Grade Laboratory Science, a Backbone to Build On."

Sidney P. Harris, Bayside High School, Bayside, N. Y. "A Gravimetric Approach for the High School Chemistry Laboratory at Negligible Expense."



DAVID T. SMITH

Alexander Haslam, St. Alban's School, Washington, D. C. "A Comprehensive Program for Grades Four Through Eight."

Thomas M. Haynes, Washington High School, Indianapolis, Ind. "Life in the Soil Depths."

Paul L. Hunsberger, Kutztown Area Junior High School, Kutztown, Pa. "Astronomy 1959."

Paul A. Johnson, Abraham Lincoln Junior High School, Rockford, Ill. "How to Teach the Barometer and Give It Meaning."

Norbert J. Konzal, Phoenix Union High School, Phoenix, Ariz. "An Experiment: The Use of Radioactive Phosphorus to Trace the Path of Minerals and Water to the Leaves of Plants."

Edward G. Kreppert, Palm Springs Junior High School, Hialeah, Fla. "Teaching by Analysis of a Current Popular or Semi-Popular Magazine or Newspaper Article."



THOMAS E. THORPE, JR.

Clifford T. LaRoge, Normandy High School, St. Louis County, Mo. "Microchemical Projection."

George L. Lehmburg, Spring Valley Senior High School, Spring Valley, N. Y. "Peg-Board Demonstrator."

Edmond C. Lonsky, Plainfield High School, Plainfield, N. J. "Continuity in Physics Laboratory Work Through the Use of Graphs."

H. M. Louderbach, Lewis & Clark High School, Spokane, Wash. "A Spokane Summer Enrichment Program in Science."

Henry C. Martin, Palo Alto Senior High School, Palo Alto, Calif. "The High School Science Seminar."

Robert C. Morris, York Community High School, Elmhurst, Ill. "Suggestions for Increasing Respect for Basic Research Through Science Teaching."

Arthur C. Murdock, Sutton High School, Sutton, Mass. "A High School Experiment to Demonstrate the Application of Statistics to Research."

Hyland D. Packard, Port Sulphur High School, Port Sulphur, La. "Paper Chromatography."

Laurence B. Perry, Manchester High School, Manchester, Conn. "More Efficient Chemistry Instruction."

Robert F. Porter, Burlington-Edison High School, Burlington, Wash. "The Synthesis of Iodic Acid and the Effect of Its Concentration on the Speed of Reaction as Measured in Reciprocal Time."

Al G. Renner, Eliot Junior High School, Altadena, Calif. "An Improved Block-and-Breadboard Technique for Teaching Basic Electronic Experiments."

Morton S. Roggen, Erasmus Hall High School, Brooklyn, N. Y. "Biology in the Home—An Extended Laboratory Approach."

James A. Rossas, Oroville High School, Oroville, Calif. "Analogue Experiments Using Curtain Contours."

Charlotte M. Scappucci, Charlotte Country Day School, Charlotte, N. C. "The Science Roundtable."

V. Theodore Schreiber, Rothrock High School, McVeytown, Pa. "Planet X Project."

Robert L. Silber, Central High School, Evansville, Ind. "The Science Department: A Promoter of Interdepartmental Cooperation."

Sr. M. Ambrosia, I.H.M., Holy Redeemer High School, Detroit, Mich. "Buoyancy: An Introduction to Many Basic Physical and Mathematical Concepts."

Sr. William Susannah Harahan, S.N.D., Notre Dame High School, Moylan, Pa. "Radioactivity, Alpha, Beta, Gamma."

Sr. M. Wilfreda Stump, Ad. P.P.S., Sacred Heart Academy, Wichita, Kans. "The Largest Biology Lab—The Great Out-of-Doors."

Sr. Mary Emilia Weiler, St. Agnes Academy, Alliance, Nebr. "That 'General Science' Problem."

John E. Smith, Nyack High School, Nyack, N. Y. "Raising the General Level of Science Instruction."



HARRY K. WONG

William M. Smith, Thomas Carr Howe High School, Indianapolis, Ind. "Biology III, An Advanced Course for the Senior High School."

Laurence E. Snyder, Paradise Junior-Senior High School, Paradise, Calif. "Experiments Involving Quantitative Aspects of High School Biology."

Robert L. Stanger, Long Beach High School, Long Beach, N. Y. "I Can Demonstrate Epilepsy and Its Treatment in Class."

Charles W. Stonebarger, University Lake High School, Hartland, Wis. "On Building Bridges."

Arthur G. Suhr, Jefferson High School, Jefferson, Wis. "Demonstrations and Activities for Teaching Astronomy."

Kenneth J. Torgerson, Doolen Junior High School, Tucson, Ariz. "A Problem Method of Teaching Eighth Grade Science."

Raymond W. Traynor, Burbank Senior High School, Burbank, Calif., and **Robert J. Woodhead**, Sutter Union High School, Sutter, Calif. "An Inexpensive Student-type Spectroscope."

A. Mason Turner, Orangeburg High School, Orangeburg, S. C. "Bringing Science into Mathematics."

Everett M. Walton, John Marshall High School, Rochester, Minn. "Oxidation-Reduction in Terms of Energy Changes."

Elbert C. Weaver, Phillips Academy, Andover, Mass. "Tools for Science Teaching."

Donald A. Williamson, Bethesda-Chevy Chase High School, Bethesda, Md. "The Research Team, a Means of Demonstrating Certain Concepts of Mathematics."

Harold J. Wilson, Jr., Avon Grove Area High School, West Grove, Pa., and **Douglas A. Roberts**, Landenberg School, Landenberg, Pa. "Demonstration of a Synapse."

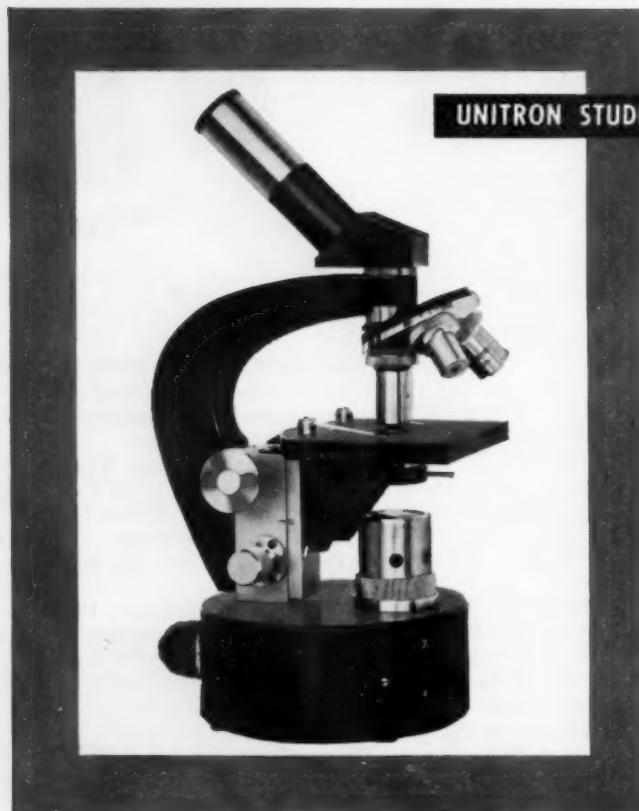
Gerald L. Witten, Grant County Rural High School, Ulysses, Kans. "A Line on Graphing."

Dominic A. Zarlengo, East High School, Denver, Colo. "The Addition and Subtraction of Colors Simplified."

Joseph J. Zucca, Carlmont High School, Belmont, Calif. "A Practical Unit of Mineralogy for General and Earth Science Classes."

Paul R. Zurakowski, Mt. Clemens High School, Mt. Clemens, Mich. "A Continuous Cloud Chamber Experiment for High School Laboratory."

UNITRON student microscopes offer



UNITRON STUDENT AUTO-ILLUMINATION MICROSCOPE, MSA

The UNITRON Student Auto-Illumination Microscope, Model MSA, employs a newly designed stand in which all components and controls are within easy reach. The inclined eyepiece tube allows comfortable posture and may be turned in any optional observing direction to permit two students sitting side by side to share a single instrument. With the built-in illuminating system of the superior low-voltage type, each student is assured of the correct lighting. The transformer is conveniently housed in the microscope base itself where it contributes to the stability of the stand rather than to the clutter of the laboratory table.

Model MSA comes complete with triple revolving nosepiece and three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X; coarse focusing with safety stop; fine focusing; condenser and iris diaphragm; filter holder and filter; accessory substage mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

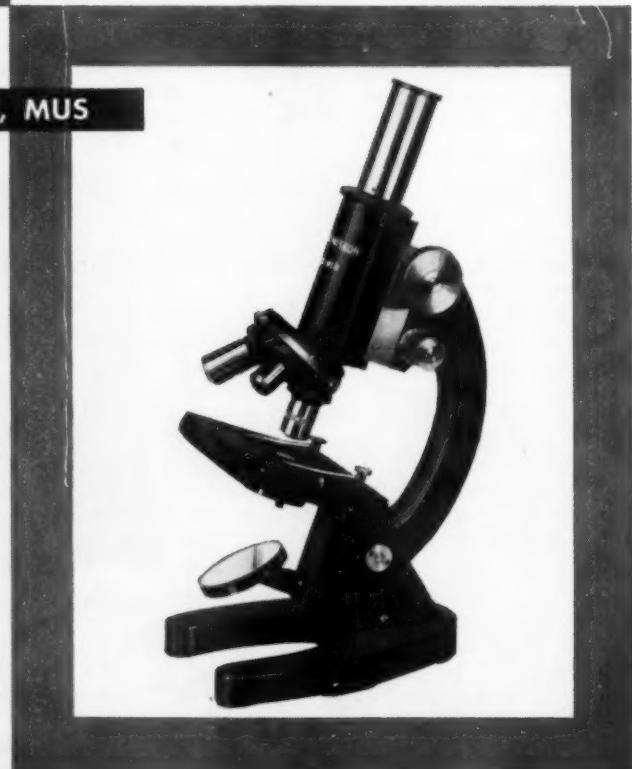
In quantities of
25 or more... \$94.16 only **\$107**

UNITRON STUDENT MICROSCOPE, MUS

Despite its low cost, UNITRON Model MUS offers features lacking even in much more costly models usually offered for student use. For example, both fine and coarse focusing are provided — not merely a single focusing control; an iris diaphragm to regulate aperture for highest resolution — not merely a disk diaphragm; and a condenser system for optimum illumination.

The optical performance of Model MUS at each of its magnifications is equivalent to that of expensive research models. All mechanical parts are machined to close tolerances and the stand is beautifully finished in black and chrome. Model MUS comes complete with triple revolving nosepiece and three objectives: 5X, 10X, 40X; choice of two eyepieces from: 5X, 10X, 15X; coarse focusing (accessory safety stop available); condenser with iris diaphragm; inclinable stand; plano-concave mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

In quantities of
25 or more... \$66.60 only **\$74**



unexcelled quality at budget prices

UNITRON DISSECTING ADS

Heavy base, micrometric rack and pinion focusing, arm rests, mirror and background plate, large glass stage plate, Steinheil magnifiers.

ADS: for 10X, 20X
\$32.50
ADSA: for 5X, 10X, 20X
\$36.50



UNITRON PHASE MPEA

The first student phase model ever to be offered. Observe protozoa, plankton, etc. in the living state without chemical staining. Objectives: 4X, P10X, P40X. Eyepieces: 8X, 15X. Condenser and phase diaphragm. Write for a reprint of Professor Corrington's article on this remarkable instrument.

MPEA.....
\$99
(f.o.b. Boston)



UNITRON STEREOSCOPIC MSL

A wide field, binocular, 3-D dissecting model. Diopter and interpupillary adjustments. Removable glass stage plate. One set of eyepieces for 10X, 20X or 30X included; others available at extra cost.

Model MSL.....
\$110
(f.o.b. Boston)



UNITRON PHOTOMICROGRAPHY SET

Duplicates the performance of costly apparatus. Fits any standard microscope. Mounting brackets adjust for your camera. Viewing telescope allows focusing and selection of field while the camera is in position.

Model ACA...
\$39.95



UNITRON LABORATORY MLEB

Uses the same large, heavy stand as our research models. Three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X. Coarse and fine focusing. Condenser and iris diaphragm. Filter holder and filter. Mechanical stage available.

MLEB.....
\$118



ACCEPT A FREE 10 DAY TRIAL

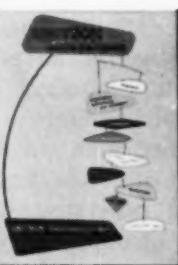
We invite you to try any UNITRON Microscope in your own classroom for 10 days at absolutely no cost or obligation. Let our instruments prove their value and quality to you, before you decide to purchase. You will see for yourself why UNITRON is the choice of America's leading universities, schools, and industrial laboratories.

THIS COMPLETE CATALOG ON UNITRON MICROSCOPES IS YOURS FOR THE ASKING!

Gives complete information on the UNITRON Models described above as well as on many others for all types of microscopy. You will find this informative publication a valuable addition to your files.

QUANTITY DISCOUNTS AVAILABLE ON ALL MODELS

Prices include wooden cabinet, plastic dustcover, and free delivery to your school unless otherwise noted.



UNITRON

INSTRUMENT DIVISION OF
UNITED SCIENTIFIC CO.
204-206 Milk Street • Boston 9, Mass.

Please send me your complete catalog on
UNITRON Microscopes, 8-B.

Name and Title_____

School or College_____

Address_____

City_____ State_____

Research for High School Science Teachers

By DONALD A. SCHAEFER

Science Teacher, Bettendorf Senior High School, Bettendorf, Iowa

MOST of us who teach high school science often discuss research and research methods. Many of us, however, have never had the time nor the opportunity to do individual research. In our undergraduate work, the time has been primarily consumed in required course work for a particular degree designation, and as many hours as possible are devoted to subject-matter courses in our chosen fields. In recent years, the weakness in subject-matter training has been corrected to a great extent by Summer Institute Programs in the subject-matter areas. This

writer, like so many others, has been privileged to attend many of these Institute Programs, and has thus been allowed to increase subject-matter competence in a way which would have been otherwise impossible. In none of these programs, however, was there time or opportunity to do research.¹

Here at Bettendorf Senior High School, an advanced group of science students have the opportunity and the

requirement of individual research. This is as a regular part of their course, though all work on their research projects must be done outside of class time.² As the teacher and project advisor for this group of students, I have experienced the students' need for help in acquisition of research information. Though this part of our own science program may not be representative of the majority of schools, it is the opinion of this writer that it may well be in the not too distant future. Even without an advanced science course, the practice of doing a research project (by the student) is becoming increasingly com-

¹ Institutes attended by author at Carnegie Institute of Technology, 1952; University of Wisconsin, 1956-57; Michigan State University, 1957; and Reed College, 1958.

² Donald A. Schaefer. "Advanced Science for Gifted Students." *The Science Teacher*, 25:269. September 1958.

mon. The greater number of regional and local science fairs and the increase of entries in such national competitions, as the National Science Talent Search and the Future Scientists of America, indicate the increasing demands for knowledge of research placed upon the average teacher.

Last summer (1959), the opportunity to do nine weeks of uninterrupted research was afforded thirteen high school and small college teachers of science. The National Science Foundation awarded grants to this group for work at the Denver Research Institute, and to seven more teachers in the same category for similar work in various laboratories of the University of Denver. Each participant was placed largely on his own in research for the first time, and was assigned to a particular project on the basis of his own background and special interests. The projects were both of the "pure" and "applied" variety, and ranged from "A study of radiation in the upper atmosphere" and "Microminiaturization" to "The plastic deformation of hyper-velocity particles." Some participants worked as part of a research team on a project already under way, while others worked primarily on their own projects devised just for this program. Research scientists were assigned each participant in the role of project advisor, and worked in varying degrees with that participant through the entire nine-weeks program.

Since the project for which the author was selected was "An X-ray diffraction analysis of solid products formed in the thermal decomposition of aluminum nitrate nonahydrate," the advisors were research specialists in this general area. Dr. H. P. Leighly, head of the graduate metallurgy department at Denver University and a research metallurgist at DRI, and Robert McCune, head of the X-ray Laboratories at the Denver Research Institute, were assigned as advisor and project supervisor, respectively.

Exactly how did they supervise the work of this writer, and thus carry out a task similar to the work we would do with our students? A month before the program began, Dr. Leighly sent this writer an excellent text on X-ray diffraction,³ in which he pointed out the key

problems which illustrated basic concepts to be mastered. Since the X-ray diffractometer was the primary instrument to be used in the particular research study, and since Dr. Leighly realized that this writer had never previously worked with such an instrument, he chose the most efficient method to insure acquisition of necessary background. Some of these problems were worked and returned to him for correction and criticism. In this way, it is the feeling of the author that approximately two-weeks time was saved in acquiring necessary background, and this two weeks was invaluable as the work advanced.

Upon arrival at DRI, the first man this writer met was none other than Dr. Leighly. He had anticipated the feelings of doubt and the misgivings of the participants about to embark on this new and intensive undertaking, and tried immediately to make DRI seem like home. Following a brief orientation period with the director of the entire program, Dr. Leighly introduced the author to Mr. McCune and conducted a brief tour of the laboratories, with introductions to all personnel. There was little doubt, after the first morning with these men, that they would do everything they could to make the research experience meaningful, and that as complete freedom as possible would be afforded.

When one is first heading into a completely new experience, such as research, assurance and confidence provided, as well as a personal interest, are of great importance. The same uncertainty as mine must face our students as they begin thinking about doing a research project, and as they wonder if they have the capabilities to do successful research work. They need the same sense of assurance and confidence so ably conveyed by the advisors to me at DRI. Just as important is the understanding that, right from the start, the thinking and work must be done by the student. *Freedom* to pursue the various avenues of a research problem must carry with it the *responsibility* for such pursuit, in order to achieve its purpose.

During the first week in the laboratory, direction was given in the specific use of the Norelco diffractometer. Mr. McCune furnished samples of materials with well-defined crystalline structure so that clear and easily identifiable diffraction patterns resulted. (Here the material of the text made it possible to become adept in a minimum of time.) By using such materials as titanium dioxide, corundum, etc., it was possible to focus complete attention on learning to operate the diffractometer and "read" diffraction patterns, since these patterns were clear and simple.

After the first week of orientation with the instrument and further study,

(a) Electron transitions and the corresponding radiations.

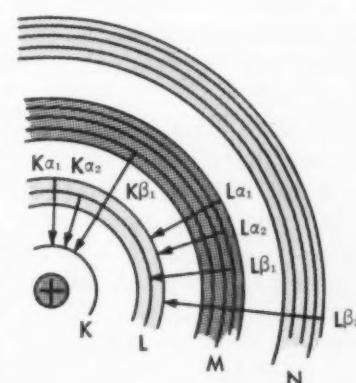
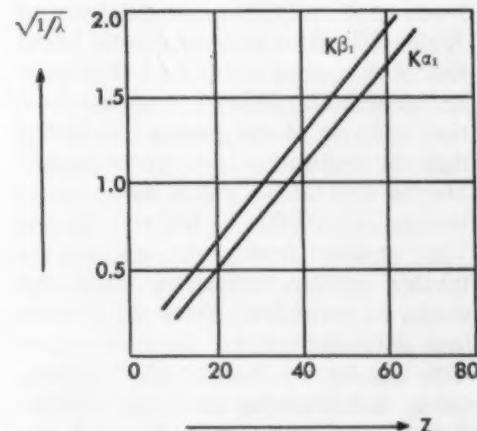


FIGURE 1.



(b) Almost linear relation between $1/\lambda$ and Z . In formula form, known as Moseley's law, and written: $\sqrt{\nu} = C(Z - \sigma)$ where C and σ are constants, and ν is the line frequency.

³ B. D. Cullity. *Elements of X-Ray Diffraction*. Addison Wesley Publishing Company, Inc., Reading, Massachusetts. 1956. p. 505.

of the literature, as it pertained to aluminum compounds, a conference was held with the two advisors and Mr. George Rauscher (a graduate student who had completed a study of aluminum nitrate nonahydrate). At this conference, the author was informed of the specific tests that were performed by Mr. Rauscher, as well as the specific difficulties and results he was able to note. Numerous sources of information were also suggested at this conference from which more information could be obtained regarding work done on this study. Initial procedures for beginning the research study were also jointly decided upon and planned. The advisors were available during the project to aid in matters pertaining to background. They encouraged the author to determine the tests to be run and analyses to be made and, insofar as possible, made available any equipment or facilities needed for these tests.

In the following paragraphs, an attempt will be made to give the reader a feeling for the specific problem, background required, experimental procedure followed, and the conclusions this writer felt were warranted on the basis of experimental work done. An attempt will be made to correlate modified excerpts from a thesis report submitted (though not required) at the close of the program. Space will not permit any extensive coverage, but enough to present a clear picture.

Modified excerpts from research report of author. In August 1958, a sample of a corrosion product from an aluminum vat was sent, for analysis, to the Denver Research Institute X-Ray Laboratory. When an attempt was made to identify this material from an X-ray diffraction pattern, it was found that it was amorphous and thus gave no identifiable pattern. A decomposition analysis of the product indicated that the substance lost approximately 50 per cent of its initial weight after heating at 1000° C for two hours. The residue then gave an unmistakable pattern for alpha aluminum oxide, or corundum. Since the weight-loss data showed no correspondence with any known hydrate of aluminum oxide, and since the vat had contained concentrated nitric acid, Mr. McCune surmised that the initial sample might have been a hydrate of aluminum nitrate. Further correspondence with the sending organization revealed that

the initial corrosion product had been heated overnight at approximately 100° C before it was sent. This presented the additional probability that the corrosion product itself could have been partially decomposed by the initial heating, and the sample received by the laboratory had actually been one of the early decomposition products of such a breakdown.

Mr. Rauscher, then beginning his thesis work for a Bachelor's Degree in Chemistry at the University of Denver, decided to concentrate on aluminum nitrate nonahydrate. He found that this compound was exceedingly difficult to work with, since it was highly deliquescent. During the time of a diffraction "run" the sample would pick up or lose water, depending upon the relative humidity of the surrounding air, and there was no way to be certain that it was the "same" material.

The additional facts that the decomposition of aluminum nitrate nonahydrate is likely to occur in steps, that the dissociation and recombination processes will occur simultaneously, and that amorphous intermediate products are possible and even probable, all add complications to such an analysis. Most sources indicate that the most profitable method in such cases is the loss of weight method, where the reaction is followed on a micro-balance.⁴

Because the water of hydration is not always held in the crystal lattice in the same way, different things may occur when the material is decomposed by heating. The lattice of the residue may be practically identical with that of the inorganic constituents of the original hydrate, as in the case of the zeolites; it may have a phase showing little evidence of crystalline structure at all; and finally, the dehydrated residue may crystallize to give an entirely new crystalline phase.⁵

Principles of X-ray diffraction. Though X-ray diffraction requires a crystalline nature in the material to be analyzed, and amorphous material (or material with crystallitic size of less than eighty Angstroms — approximately) does not produce a definitive pattern, it is regarded as one of the outstanding methods of solid-state analysis,⁶ and

⁴ W. E. Garner, Editor. *Chemistry of the Solid State*. Butterworths Science Publishers, London, England. 1955. p. 184-233.

⁵ *Ibid.*

⁶ *Ibid.*, p. 299.

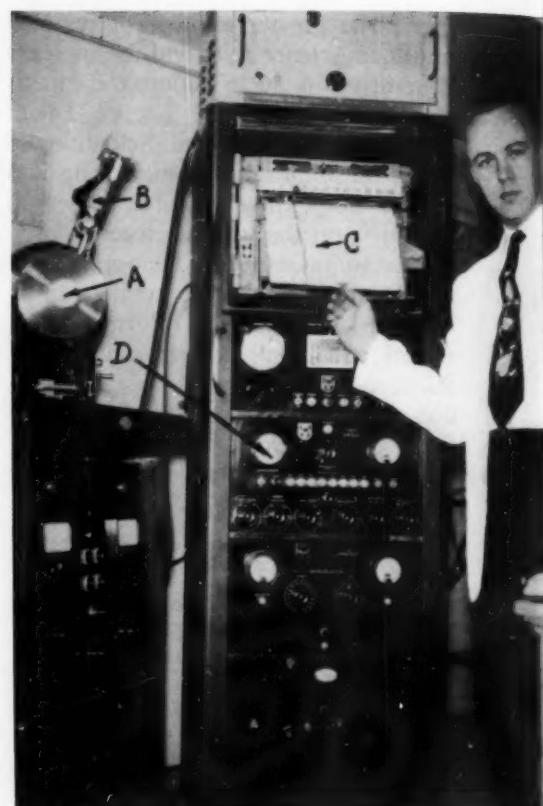


FIGURE 2.

The author with Norelco diffractometer used in study.

- A. Protective scatter-shield in which powder specimen is placed.
- B. Scintillation counter, detector unit which scans region for diffracted beams and measures 2θ angles automatically.
- C. Resultant graph of 2θ values versus an intensity measure.
- D. Scaling unit and power unit for detector.

most research studies substantiate its value.

The basic principles involved in diffraction work concern the fundamental electromagnetic nature of X-radiation, and the phenomena of constructive and destructive interference resulting from monochromatic radiation being scattered from regularly recurring points. The X rays themselves result when outer adjacent electrons fall into spaces in inner shells from which these inner electrons have been ejected. When electrons of sufficient energy bombard an atom, an electron may be forcibly ejected from the K shell, and an electron from the M shell, or some higher shell, may then fall into the vacancy. No matter which particular electron falls to the lower energy level (K) vacancy, the emitted energy is quantized. If this were the only source of

X-radiation we would get only very definite and quantized radiations from each element, and each transition would result in the particular wavelength radiation corresponding to the energy level difference of the shells. This, however, is not the case, and each element will emit a continuous spectrum of X rays. This is due to each impinging electron actually losing its energy in an unpredictable series of steps by successive impacts, rather than by a single impact.⁷ [A more detailed explanation is omitted in this article.]

If the voltage across the electrodes of an X-ray tube is increased, we find definite maxima sharply appearing in the X-ray spectrum for each target element and rising higher above the continuous X-ray spectrum background as the voltage is further increased. These maxima form the characteristic X-ray line spectrum for an element

⁷ Cullity. *Op. cit.*, p. 4.

FIGURE 3.

Diffraction pattern tests for residues of samples of nonhydrate heated from 260° to 700° C.

- A. 260° C for 232 hours.
- B. 560° C for 46 hours.
- C. 560° C for 77 hours.
- D. 560° C for 116 hours.
- E. 700° C for 22 hours.
- F. 700° C for 69 hours.

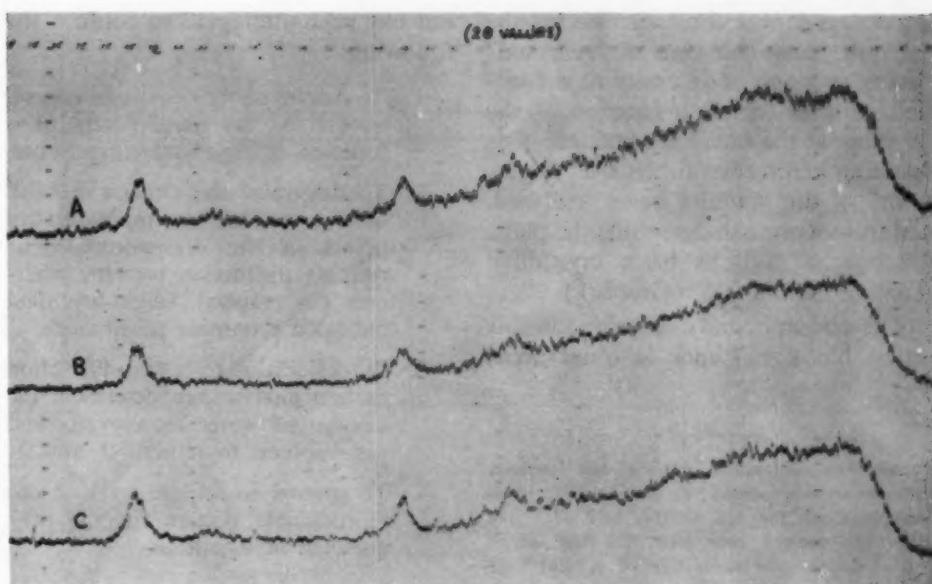
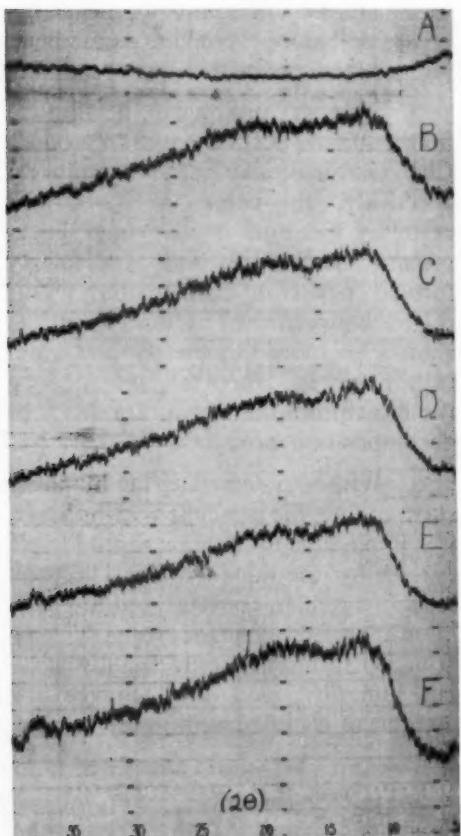


FIGURE 4.

Diffraction patterns from 5° to 76° C (2θ values), for samples heated at 700° and 800° C.

- A. 700° C for 21.5 hours.
- B. 700° C for 69 hours.
- C. 800° C for 65 hours.

(Figure 1). They consist of lines called the K alpha, the K beta, L alpha, etc., depending upon their source.⁸ Because of their relative intensities, in comparison to other lines emitted, the three most important to X-ray diffraction are the K-alpha one, the K-alpha two, and the K-beta one lines. By use of filters which allow the K-alpha radiation to pass, and are nearly opaque to the K-beta radiation, it is possible to get very nearly monochromatic radiation. (The wave length of the K-alpha one radiation for copper is 1.5405 Angstroms, and the filter is of nickel.) Since this radiation has a definite wave length and remains a constant, the only variation in a diffraction pattern for any material will have to be due to the plane spacings of atoms in crystalline structures being analyzed. In a relation originally formulated by W. L. Bragg, and now known as Bragg's Law, it was determined that:

$$n \lambda = 2d' \sin \theta$$

where λ is in the incident wave length, d' is the spacing between the scattering centers (in the case of a crystal, the distance between planes of atoms recurring in the crystal), and θ is the angle of incidence. The letter n is called the order of the diffraction and is always integral, since it represents the number

⁸ Henry Semat. *Introduction to Atomic Physics*. Rinehart & Company, Inc., New York. 1946. p. 268.

of wave lengths in the total path difference. The waves involved will reinforce each other if they are just "in step" when they reach the detector; that is, if they are an integral number of wave lengths out of phase. If the path difference is only one wave length, reinforcement occurs, $n = 1$, and the phenomenon is called a first order "reflection." It is thus apparent that only at specific points and angles determined by the d' spacing of the planes of atoms will a given monochromatic incident beam reinforce another. Whether the specimen is a single crystal or a powder sample, we get a diffraction pattern which is unique for the material rendering the pattern.

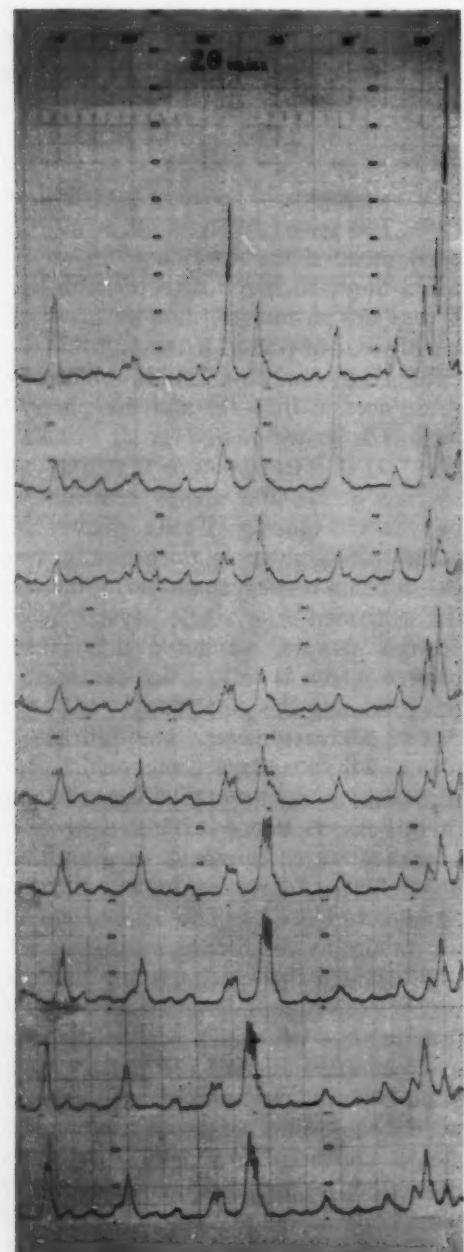
The Diffractometer. The diffractometer is the standard device which directs this monochromatic X-ray beam (in this case from copper) into a powder specimen which is placed in a special holder in the target area of the diffractometer (Figure 2). The beams, which are favorably reinforced by their passage through the specimen, are picked up by a scintillation counter as it scans the region in which these beams emerge. These signals are passed to a scaling unit and amplification unit, which cause horizontal deflections of a pen so that the amplitude of the deflection is proportional to the intensity of the radiation being detected. Since the recording graph paper is mov-

ing forward at a constant rate, as the detector scans the area of "reflected" beams, a graph of intensity as a function of time (or as a function of the 2θ value at the time) is obtained. This resulting graph then forms the "fingerprint" of the material being analyzed, and from it one can determine the plane spacings as well as basic crystallitic shape of the material (Graph 1).

The research study described in this article has significance in other areas

FIGURE 5.

Nonahydrate diffraction pattern test sections. Patterns were repeated at half-hour intervals beginning with the top section, and each one below run one-half hour later. The last section was produced upon completion of a total front region run from 5° to 90° C (2θ values).



but has been attempted to confirm the following:

1. To determine the decomposition sequence of the nonahydrate as a function of time and temperature.
2. To determine the structural status of the residue at representative points in the decomposition by running diffraction patterns wherever the graphed weight-loss data indicated promising possibilities.
3. By desiccation tests and diffraction pattern analyses, to determine the amount of water loosely attached (as opposed to structural water).
4. To attempt to acquire a stable and reproducible pattern for the deliquescent nonahydrate.

The results of the decomposition weight-loss data may be noted in the graph on the following page. The small circles indicate the locations for diffraction pattern tests. Sample diffraction patterns, from completely amorphous material to that just beginning to show crystallite growth, may be noted in Figure 3, while the diffraction patterns in Figure 4 show definite peaks beginning to form, so that tentative identification of the residue becomes possible. Figure 5 shows a series of successive pattern runs for the nonahydrate itself (in which the humidity surrounding the sample was held as constant as possible), and the pattern shows clearly that if the sample has definite crystalline structure that sharp peaks at definite angles will result. It may also be noted that the peak locations seem to remain constant for the nonahydrate, but while it is adjusting to constant humidity conditions, the intensity of each peak varies greatly.

Though the major part of the information regarding experimentation cannot be included, the reader may find interesting the data accumulated on the decomposition sequence of the nonahydrate and the accompanying diffraction pattern information. The conclusions are:

1. Either a desiccant or very low temperature is able to remove the first three waters of hydration from the nonahydrate, producing the hexahydrate. The diffraction pattern indicates that the crystal lattice of the hexahydrate and the nonahydrate are fundamentally the same, since the d' spacings (indicated by peak locations) are repeated

completely, while the peak intensities vary a great deal.

2. After the hexahydrate forms, the removal of additional water causes a breakdown in the nonahydrate-like structure, and the material becomes increasingly amorphous. The water removed here must therefore be structural water, rather than water loosely attached. (The nitrate groups apparently come off as nitric acid which is decomposed into water and nitrogen dioxide—a brown gas observed to be released at all higher temperatures.)

3. At no time, below 560° C, does any new crystalline structure emerge, and all patterns may be interpreted as mixture patterns gradually changing from the nonahydrate-like structure to totally amorphous material at 260° C. At this temperature, the weight-loss data shows precise correspondence with aluminum oxide monohydrate, while at 177° C the correspondence is with that of the trihydrate of aluminum oxide. This writer feels the data inconclusive as far as actually determining whether these are the monohydrates or trihydrates of Al_2O_3 .

4. If the nonahydrate, or any decomposition product from the nonahydrate, is heated to 1000° C for a period of two hours or more, the material forms alpha aluminum oxide which becomes definitely crystalline as the heating process continues.

5. Though prolonged heating at 560 , 700 , and 800° C seems to produce Chi-, Gamma-, and Kappa-alumina respectively,⁹ this cannot be stated with certainty because of the high background radiation and indefinitely formed peaks in each pattern. This region between 500° C and 1000° C should be more completely and carefully explored, since this seems to be the most promising region for study of decomposition products.

6. Without controlling the humidity surrounding the specimen completely, it is impossible to obtain a reproducible pattern for the nonahydrate. The peak locations remain constant, but the peak intensities are changed in very pronounced fashion by only slightly varying humidity, and thus change the amount of water present in the sample.

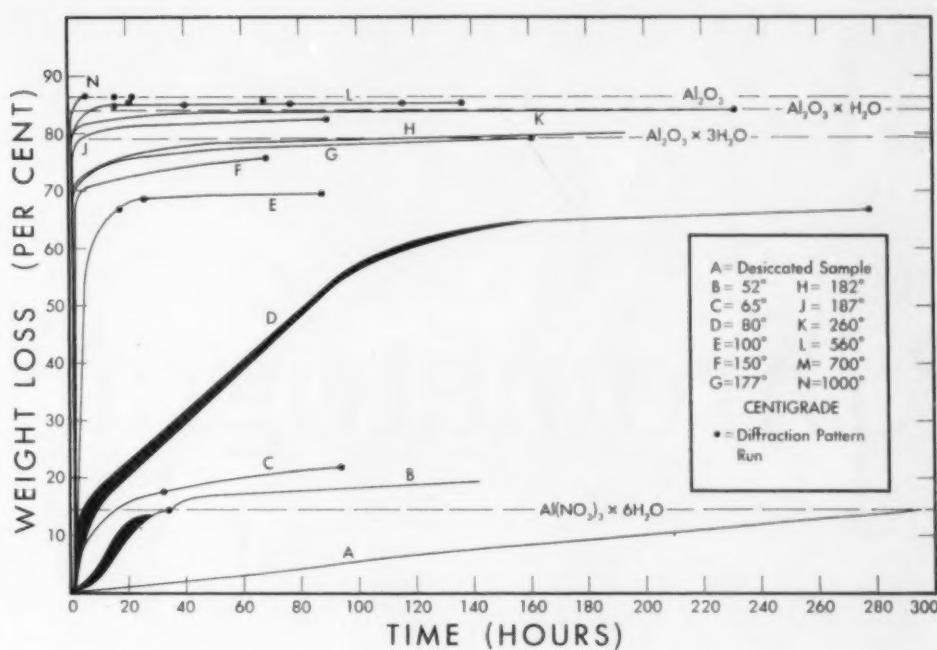
⁹ H. C. Stumpf, et al. "Thermal Transformations of Aluminas and Alumina Hydrates." *Industrial & Engineering Chemistry*, 42:1398-1403. July 1950.

Summary of values received from research work. There is a rewarding sense of accomplishment and understanding that accompanies work with an instrument like the diffractometer. The relation between wave theory, diffraction phenomena, quantized energy levels in atoms, and inter-atomic distances in crystals becomes more clear and meaningful. Bragg's Law is no longer a symbolic statement in a text, but becomes a real and workable tool leading to a fundamental knowledge about the inner nature of matter. When one prepares a tiny sample of a material, places it inside the scatter-shield of the diffractometer, and then analyzes the peaks and valleys on a sheet of graph paper, a real appreciation for the *power* of such indirect reasoning processes is gained. These same formulas and ideas must be made real for all our students who continue in the field of science as it becomes ever more theoretical and symbolic. The feeling for the intimate relation between the symbolism of a formula, or mathematical statement, and the "realism" of nature, must be transmitted, and we cannot transmit with maximum efficiency that which we do not ourselves feel. We will at best teach *about* it.

What was learned regarding the question of specifically aiding students wishing to do research? *First*, unless the individual actually does the work and most of the thinking himself, he cannot get maximum benefit from such work. *Second*, the primary aid to be given to one just beginning experience in individual research is help in *finding* the information. *Third*, the student must be made completely aware of the necessity for absolute integrity in his work. We must encourage a sort of scientific skepticism regarding conclusions. Any conclusion founded on insufficient evidence is a disservice to the pursuit of knowledge.

Conclusions

This writer did not fully realize himself that the research person is really in a competitive field, subject to numerous pressures which could easily lead to publication of "conclusive" results which are at best "indicative" results. There is the necessity for maintaining a grant for a particular research project, a grant which may be partially dependent upon *favorable* results from the project work. There is the pressure



GRAPH 1.

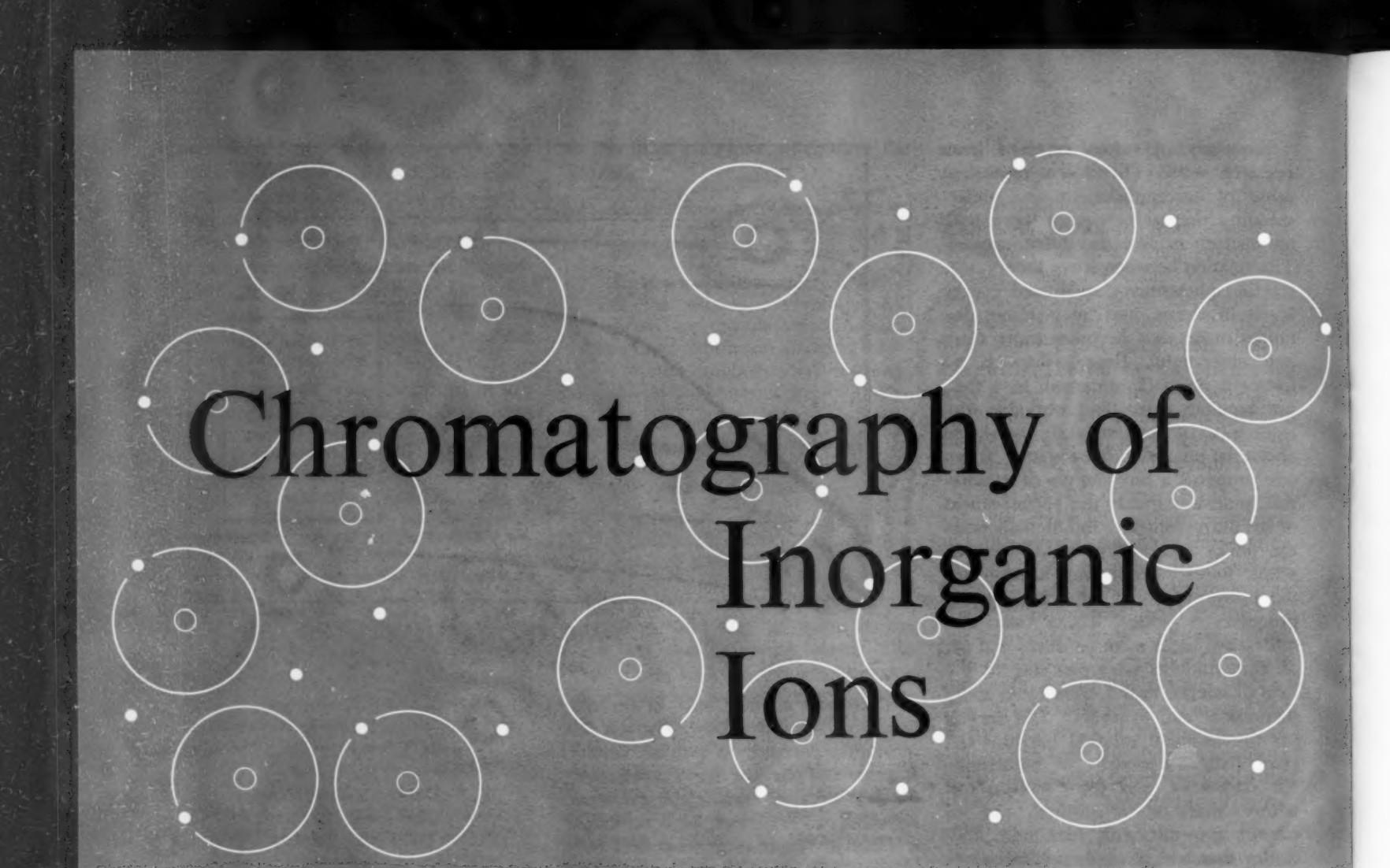
of the desire to be "first" in the discovery of something new. There is the inevitable pressure to publish results. If a research scientist draws conclusions on the basis of insufficient evidence, regardless of pressures, he is no longer a scientist! If our students collect only "favorable" data they are learning anything but the methods of science. Science data must be developed with complete honesty above all else or knowledge is deterred rather than advanced.

If we can aid our students in finding information, in reporting *what they gain* and not *what they wish they had gained*, and if we can convey to them our honest belief that they have both the capability necessary for research and the responsibility to do their own work, we will have done our part. We will have added one new facet to their "opportunity" to learn. Isn't the provision of maximum "opportunity" for learning really our primary function in education? Each must learn for himself. We can only aid in the learning process.

Direction and encouragement, however, serve as important stimuli for student or teacher. Whether one is engaged in the classroom or in research, he should not overlook the use of these means to help others.

Bibliography

- Harold Bale and Paul W. Schmidt. "Small Angle X-Ray Scattering from Aluminum Hydroxide Gel." *The Journal of Physical Chemistry*, 62:10. October 1958.
- B. D. Cullity. *Elements of X-Ray Diffraction*. Addison-Wesley Publishing Company, Inc., Reading, Massachusetts. 1956.
- W. E. Garner, Editor. *Chemistry of the Solid State*. Butterworths Science Publishers, London, England. 1955.
- Index to the X-Ray Powder Data File*. American Society for Testing Metals, Philadelphia, Pennsylvania. 1957.
- George Rauscher. "Decomposition of Aluminum Nitrate." Bachelor of Science Thesis in Chemistry, University of Denver, Denver, Colorado. 1958.
- Allen Russell. *Alumina Properties*. Technical paper No. 10. Aluminum Research Laboratories, Pittsburgh, Pennsylvania. 1953.
- Henry Semat. *Introduction to Atomic Physics*. Rinehart & Company, Inc., New York. 1946.
- H. C. Stumpf, et al. "Thermal Transformations of Aluminas and Alumina Hydrates." *Industrial & Engineering Chemistry*, 42:7. July 1950.
- Tables of Interplanar Spacings Computed for the Characteristic Radiation of Copper, Molybdenum, Iron, Chromium, and Cobalt*. Wright Air Development Center, U.S.A.F., Wright-Patterson Air Force Base, Dayton, Ohio.
- Kurt Toegel. "Chemical Analysis by X-Ray Spectroscopy." *Scientific Instruments*, 4:1. Radio Corporation of America, New York. June 1959.



Chromatography of Inorganic Ions

By ARNOLD E. BEREIT

Chemistry Teacher, West Phoenix High School, Phoenix, Arizona

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

THE purpose of this article is to demonstrate the use of a simple chromatographic technique as a means of identifying the common inorganic ions. It is further intended to show that this method can simplify both the teaching and the development of techniques of qualitative analysis for the first-year high school chemistry student. It is also hoped that the use of this method will develop an interest for application in future investigations.

The new technique of chromatography (from *chroma* meaning color and *graph* meaning a writing) began around 1900 but it was the Russian botanist, Mikhael Tswett, who in 1903 found that leaf extracts dissolved in suitable

solvents separated out into distinct bands of color when passed through a column of precipitated chalk.

Little was mentioned in the literature about this new technique until 1931 when Kahn and Lederer separated carotenes and xanthophylls, using columns of alumina and calcium carbonate. Since then the importance of Tswett's work was realized and new methods and techniques were developed.¹

Paper chromatography was first described by Consden, Gordon, and Martin in 1944, and the use of paper chromatography in inorganic chemistry was

introduced by M. Lederer and Linstead and collaborators in 1948.²

The method of circular paper chromatography as a tool of qualitative and quantitative analysis was developed by John G. Surak and Robert Martinovich in 1954.³ This method is often referred to as the horizontal migration method.

EQUIPMENT (See Figure 1.)

1. Two Petri dishes the same diameter, using the two tops and two bottoms as one unit.
2. Filter paper—Whatman No. 1, 11.5 cm in diameter.
3. and 4. To save time in cutting the filter paper a pattern can be cut from a convenient piece of metal, using a razor blade (VI) and leaving about 1 cm from the center as a wick.
5. A capillary pipette can be substituted for the homemade pipette. It

¹ Edgar Lederer and Michael Lederer. *Chromatography—A Review of Principles and Applications*. Elsevier Publishing Company, New York. 1953.

² *Ibid.*

³ J. G. Surak and R. Martinovich. "Circular Paper Chromatography in Qualitative Analysis." *Journal of Chemical Education*, 22:95. January 1955.

was found that the student can gain an insight into the usefulness of drawing glass by making his own pipette and obtaining a small enough opening to be used in this experiment.

- Proportional divider for determining the R_{fe} factor.⁴ (A) This piece of equipment is optional but again the student gains a greater understanding of the chromatography in determining an unknown by the use of the divider. (The R_{fe} factor is defined as the ratio of the distance from the initial spot to the ion to the distance from the initial spot to the edge of the solvent.)

PROCEDURE

- Cut a wick about 1-cm long and .3-cm wide from center of the filter paper, in several pieces of 11.5-cm filter paper. Fold the wick at a 90° angle to the paper.
- Using the pipette place one drop of the solution to be analyzed on the center of the filter paper directly on the edge of the fold for the wick.
- Place about 10 ml of the developing solvent in a Petri dish and place the filter paper with the wick in the solution.
- Place the equal-diameter half of the Petri dish on top and let developing take place for the required time. (See Figure 2.)
- Remove filter paper, mark farthest point solvent has migrated, and let dry.
- Identify ions present with corresponding identifying agent and by R_{fe} factor using divider.

⁴ David F. Houston, "Proportional Divider for Rapid Determination of Chromatographic R_f Values," *Journal of Chemical Education*, 22:411, August 1955.

FIGURE 2.

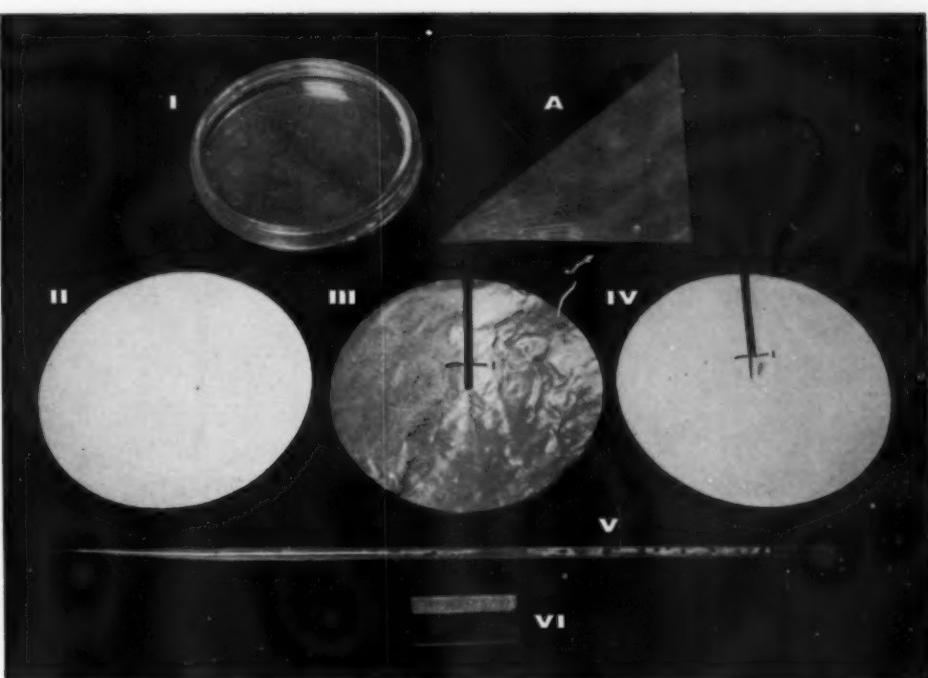
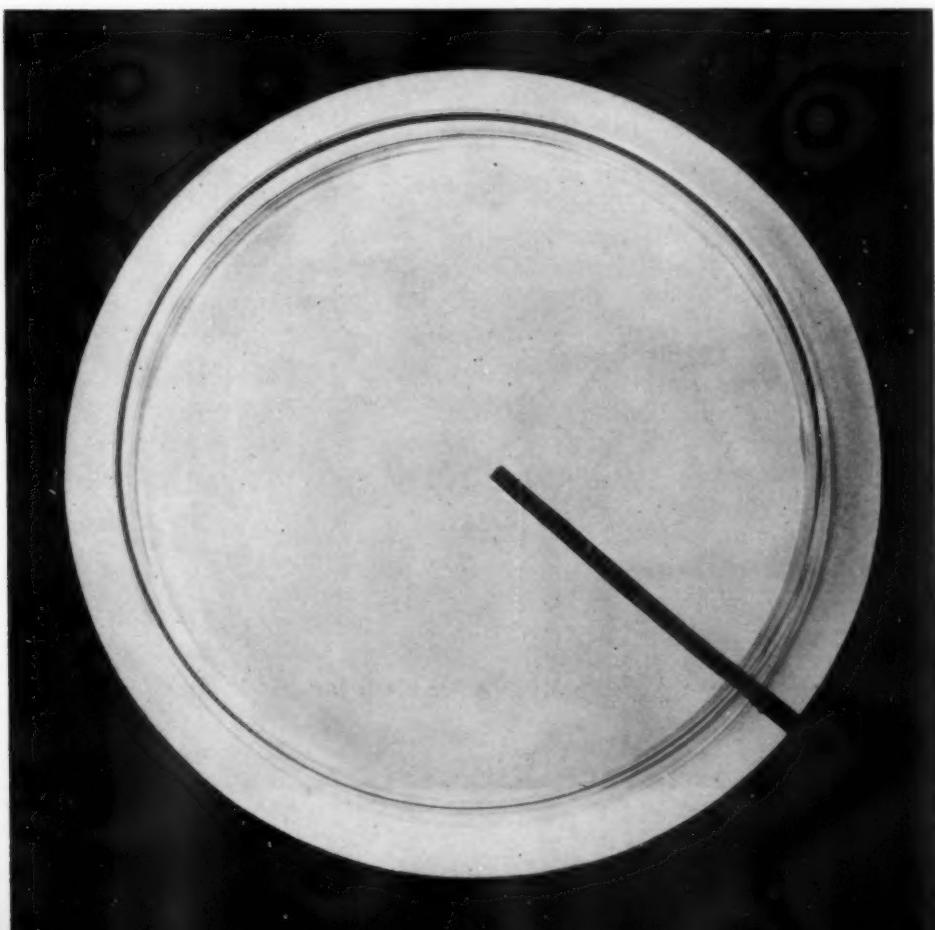


FIGURE 1.

- The cations can be separated into group by group reagents and then redissolved in solutions as nitrates or acetates of 5 per cent or less.⁵ It is felt that for the regular high school student this is too time consuming in a regular laboratory period so the ions were given to students to be tested as a group.

- Group I (Silver Group) Ag^+ , Hg_2^{++} , Hg^{++} , Pb^{++} .
- Group IIA (Copper Group) Pb^{++} , Cd^{++} , Cu^{++} , Bi^{+++} , Hg^{++} .
- Group IIB (Arsenic Group) Sb^{+++} , As^{+++} , Sn^{++} .
- Group IIIA (Aluminum Group) Al^{+++} , Zn^{++} .
- Group IIIB (Iron Group) Ni^{++} , Mn^{++} , Cu^{++} , Fe^{+++} .
- Group IV (Alkaline Earth Group) Sr^{++} , Ba^{++} , Ca^{++} .
- Group V (Alkali Metals) K^+ , Na^+ , Li^+ .

In a group each ion was developed separately and then as a group from 25-35 minutes using one Petri dish as

⁵ A convenient method of obtaining groups. This was used by several advanced students as a special project. F. J. Welcher and Richard Hahn. *Semi-micro Qualitative Analysis*. D. Van Nostrand Company, Inc., New York. 1957. p. 363, 412-29.

7 NEW KITS TEACH THE SCIENCE OF ELECTRICITY



BATTERY CHEMISTRY KIT Model 610 explains activity series, electrons, ions, corrosion, batteries, electroplating, electrolysis and generates electricity from chemical action in 11 different experiments. \$9.95.

STUDENTS LEARN BETTER WORKING WITH NEW PRODUCT DESIGN MODELS

Seven new models developed by educators and engineers demonstrate the scientific principles relating to ELECTRICITY, MAGNETISM, ELECTRONS, MOTORS, GENERATORS and ELECTRO-CHEMISTRY in 60 dramatic student experiments. Hundreds of teachers report that they cover more subjects more effectively with less effort and preparation time. The models increase student interest, curiosity and comprehension.

EASY TO USE, inexpensively priced sturdy models include full equipment, illustrated Teacher Manuals, student worksheets and portable case.

FEDERAL-AID, under the National Defense Education Act, now available for this equipment in most states.

SEND FOR FREE CATALOGUE and cost information, or a demonstration in your school without obligation.

SCIENCE EDUCATION DIVISION

product design co.

2796 Middlefield Rd., Redwood City, Cal.

MAIL COUPON TODAY

PRODUCT DESIGN CO.
2796 Middlefield Rd., Redwood City, Cal.

Please send data on Models for Teaching:
 Basic Electricity Model Motor
 Battery Chemistry Magnetism
 Magnets & Coils Turbine Generator
 Power Transmission
 Demonstrate your models in our school.

Name..... Title.....

School.....

Address..... City.....

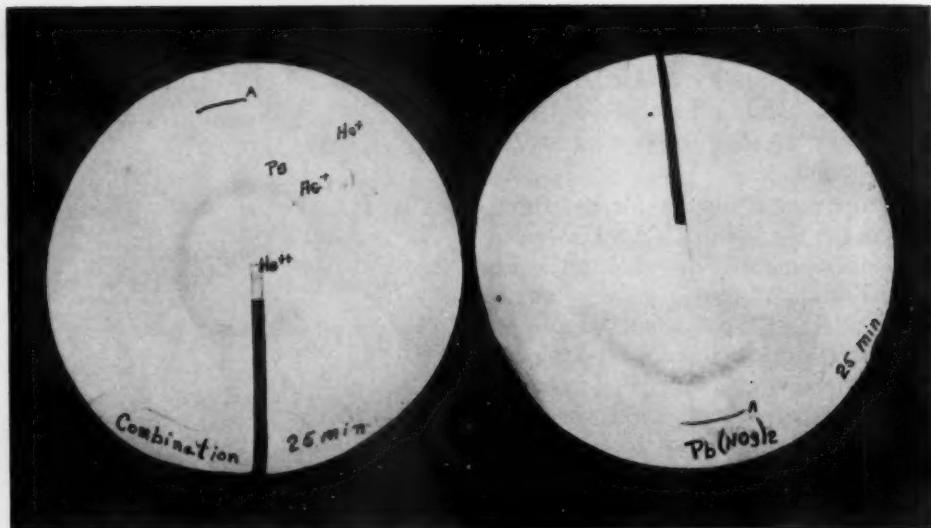


FIGURE 3.

a control, with just the solvent in it before an unknown was given. The separate ion chromatographs can be held over the unknown (against a strong light) from a group as a help in identifying the unknown ion.

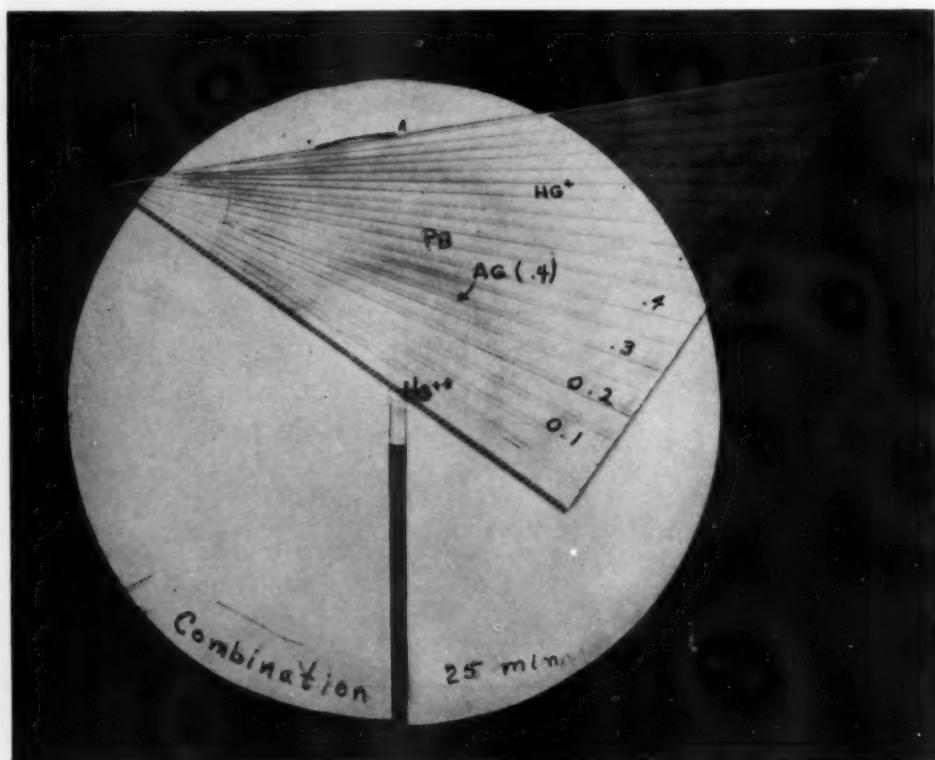
OBSERVATION

Figure 3 on the left shows the entire Group I as a chromatograph and on the right is the Pb ion. After developing,

the ions can be identified by an identifying agent for each group. In the case of Group I, H_2S is used and produces the effect as shown in the figure.

As a further aid in identifying the ions the proportional divider is used to obtain the $R_{f,c}$ factor of each ion. (See Figure 4.) The base of the divider is placed at the impregnation point and the hypotenuse is placed tangent to the edge of the developing solution. The

FIGURE 4.



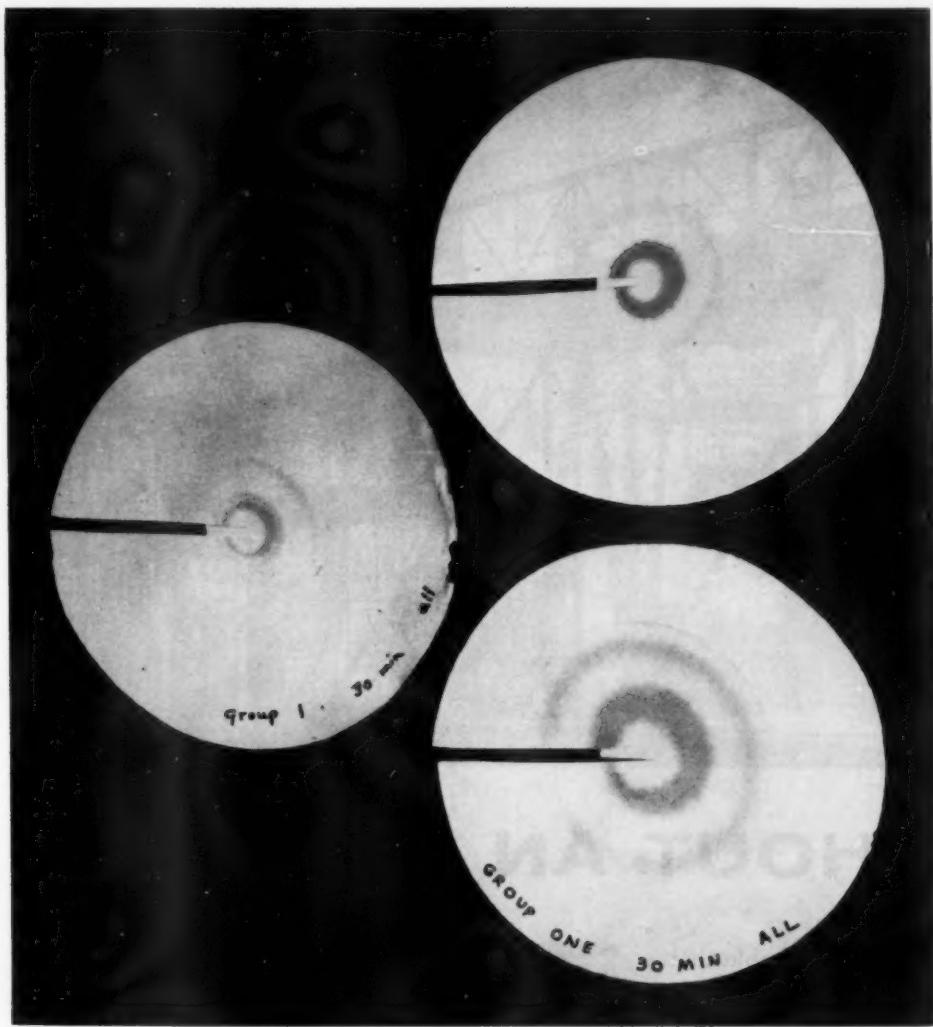


FIGURE 5.

R_{fe} value can be read to the nearest .01 at the edge of the ion-migration surface.

Below are listed the colors and R_{fe} values for Group I.⁶

Cation	Color	R_{fe}
Ag^+	Black	.30
Hg_2^{++}	Black	.00
Hg^{++}	Tan	.81
Pb^{++}	Brown	.45

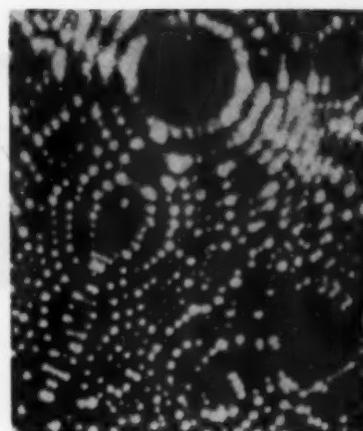
DISCUSSION

The methods given for Group I are used in the other groups of cations. Each group has its own color and its own R_{fe} values.

Circular paper chromatography experiments in the second semester of high school chemistry have proven very valuable in stimulating interest in chromatography and also in introducing qualitative analysis. There are also many advantages to using this method in chemistry.

⁶ Surak and Martinovich. *Op. cit.*, p. 97.

1. The short periods of time for developing a chromatograph lend themselves to the time allotted for the average high school laboratory period.
2. The methods and equipment used in these experiments are within the limits of understanding and capabilities of the beginning chemistry student (Figure 5 shows examples of the first chromatographs made by a high school student in second semester chemistry), but at the same time introduces them to techniques and methods that have practical application and are used today in various fields, such as isotope separation and identification and inorganic analysis.
3. All of the equipment and chemicals used can be obtained very readily and inexpensively. Such items of equipment as the pipette and divider can be made by the student.



ATOMS OF RHENIUM
Magnification: 10,000,000!

THE THIRTEEN STEPS TO THE ATOM

by CHARLES-NOËL MARTIN
118 illustrations

THIS valuable aid to science study is a photographic exploration of the invisible world. Showing objects of increasing minuteness, from snowflakes to electrons, 118 amazing pictures reveal wondrously geometrical, fantastically beautiful structures measured in millionths of a centimeter—diatoms, cells, crystals, microorganisms, molecules, the atom itself. Magnifications up to 20,000,000! An inspiring, instructive "picture book of the invisible," with captions and text by a European scientist-author.

"Scientist or layman, adult or juvenile will enjoy the photographs. The author selected them from many sources, and chose each in terms of three criteria, 'intrinsic beauty, technical perfection, and the power to stir the imagination.' They cover a wide variety of subjects . . . a magnificent collection . . . The text is simple and requires no scientific sophistication to be understood . . . The book would make a fine present for a youngster beginning to be interested in science, if he can get it away from his elders long enough to see it."

—Dael Wolfe, *Science*

"The author is adept at popularizing difficult scientific subjects for the layman." —*Science Review*

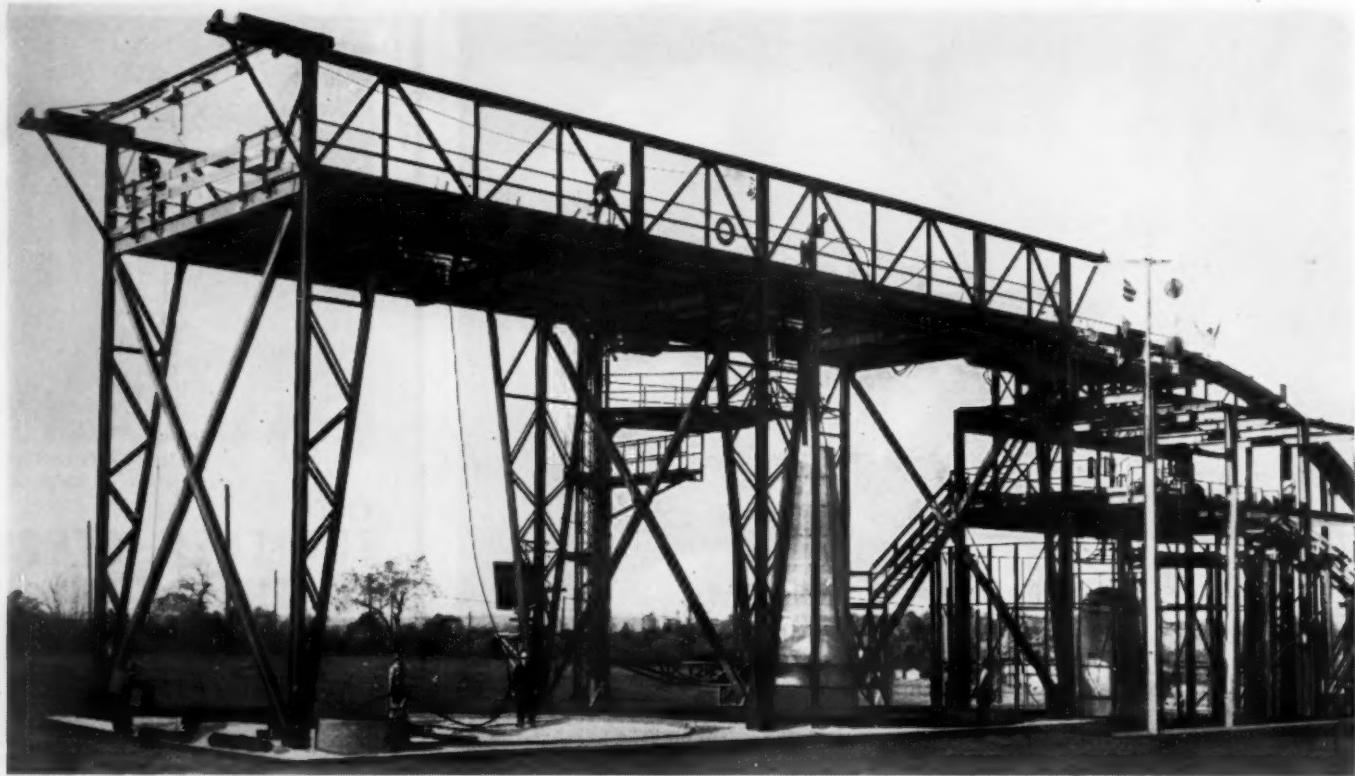
High school and adult. 6 x 8½. Cloth. \$4.95

To your bookseller, or
FRANKLIN WATTS, INC. ST
A Division of *Grolier Incorporated*
575 Lexington Ave., NEW YORK 22, N.Y.
Send me copies of **THE THIRTEEN STEPS TO THE ATOM**, by Charles-Noël Martin, at \$4.95 each. I enclose check or money order for \$.....

Name.....

Address.....

City..... Zone..... State.....



SHIP WITHOUT AN OCEAN

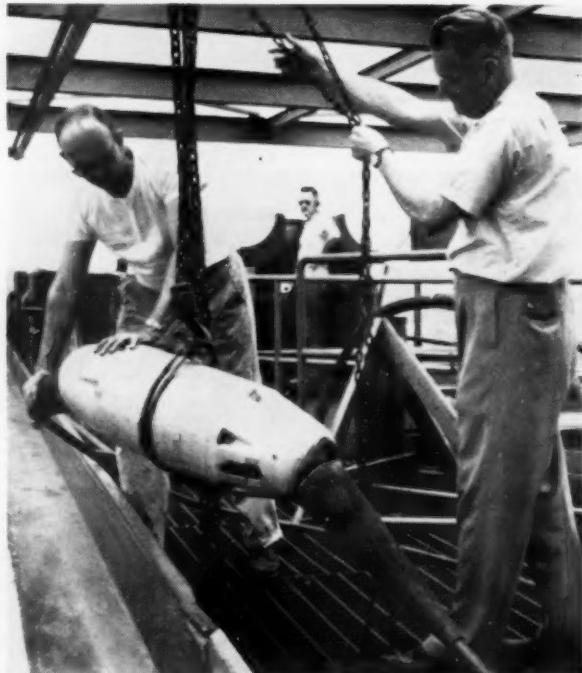
How do you lay a cable on the ocean floor—a cable that is connected to scores of large, heavy amplifiers? How do you "overboard" such a system in a continuous operation, without once halting the cable ship?

Bell Telephone Laboratories engineers must answer these questions in order to lay a new deep-sea telephone system designed to carry many more simultaneous conversations. They're experimenting on dry land because it is easier and more economical than on a ship. Ideas that couldn't even be attempted at sea are safely tested and evaluated.

In one experiment, they use a mock-up of the storage tank area of a cable ship (above). Here, they learn how amplifiers (see photo right), too rigid and heavy to be stored with the cable coils *below* decks, must be positioned *on* deck for trouble-free handling and overboarding.

Elsewhere in the Laboratories, engineers learn how best to grip the cable and control its speed, what happens as the cable with its amplifiers falls through the sea, and how fast it must be payed out to snugly fit the ocean floor. Oceanographic studies reveal the hills and valleys which will be encountered. Studies with naval architects show how the findings can be best put to work in actual cable ships.

This work is typical of the research and development effort that goes on at Bell Laboratories to bring you more and better communications services.



Experimental amplifier about to be "launched" from "cable ship." Like a giant string of beads, amplifiers and connecting cable must be overboarded without stopping the ship.



BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

ONE APPROACH TO SCIENCE SUPERVISION

By ALAN MANDELL

Science Supervisor, Norfolk County Public Schools, Norfolk, Virginia

THIS paper reports the progress of a program designed to strengthen and encourage science education in the public schools of Norfolk County, Virginia. The central idea of the program is the use of a team of *area science coordinators*, each responsible for active leadership in improving science education in all of the schools of his area.

Norfolk County composes some three hundred and fifty square miles of agricultural and industrial land with four dispersed residential sections. There are five high schools and twenty-three elementary schools, including five junior high schools. Approximately eight hundred teachers provide educational opportunities for about twenty-one thousand students.

The Area Coordinator Plan

Four master high school science teachers were selected to staff the team, one from each of the four residential

areas. One member of the team was appointed to head up the entire program and the duties and responsibilities were outlined. Since this was to be an experimental program, specific procedures and methods were not established but left up to the resourcefulness of the coordinators. The team held monthly meetings for the exchange of ideas and progress reports. In addition there were many unplanned meetings coincident with school activities.

Services Provided by the Coordinators

In summarizing the year's activities it was found that the coordinators had been called upon to provide the services discussed below. The frequency and extent of these services were varied according to the needs and interests of the teachers of different areas.

1. *Elementary Science Education*—The area coordinators served as resource persons for the elementary

teachers of their feeder schools. In this capacity they (1) provided or obtained materials and equipment and demonstrated its use to teachers, (2) worked with the teachers in developing unit plans or resource units, (3) provided demonstrations for elementary classes (often using high school students as assistants), and (4) aided the classroom teacher by encouragement and technical assistance.

2. *Junior High School Science Education*—All of the above services were also supplied to the science teachers in the junior high school program. In addition, they encouraged cooperation between junior high and senior high teachers by arranging group meetings and discussions. A series of nine workshops were conducted by the coordinators for the science teachers of the newly departmentalized seventh grade. These workshops were designed to give the teachers assistance with the subject-matter background and the techniques of teaching required for the new science curriculum for this grade.

3. *High School Science Education*—Each area coordinator taught three

Time-saving
helps for college
instructors
and students...

**CENCO'S
SELECTIVE
EXPERIMENTS
in PHYSICS**

Leading teachers have collaborated with Cenco in a continuous program of providing thorough and up-to-date treatment of laboratory physics problems. This college and junior college level series includes over 160 experiments in heat, light, electricity, mechanics, nucleonics and sound. Write for Free sample.



Serving education since 1889.

2 and 3-sheet experiments
10 and 15¢ each. Complete
set (Catalog #71994) \$15.94
(Another lab aid published
and sold only by Cenco)

CENTRAL SCIENTIFIC CO.

A Subsidiary of Cenco Instruments Corporation
1718-0 Irving Park Road, Chicago 13, Illinois
Branches and Warehouses—Mountainside, N. J.
Boston • Birmingham • Santa Clara • Los Angeles • Tulsa
Houston • Toronto • Montreal • Vancouver • Ottawa

ALBERT
TEACHERS' AGENCY
COLLEGE BUREAU

Since 1885 three
generations of the
Albert Family
have offered per-
sonalized efficient
reliable service to
educators at all
levels from kin-
dergarten through
university on a
Nation-Wide
basis.

37 SO. WABASH AVE.
CHICAGO (3)
MEMBER NATA ILLINOIS

classes in his own high school, assisted the sponsor of the science club, and worked with students in project activities.

4. *In-Service Education*—At several schools the coordinators were called upon to work with groups of teachers in grade-level, in-service training. These groups developed curriculum outlines or resource units pertinent to their grade levels. Through these activities the coordinators are developing the framework of a science curriculum for grades one through six. It is anticipated that summer workshops will provide an opportunity for elementary teachers and principals to evaluate and develop these curricular guides as useful teaching instruments during the school year.

5. *Science Open House Activity*—Each coordinator sponsored an elementary science open-house program at his high school for the feeder elementary and junior high schools. Individuals and classes displayed science projects they had worked on during the year. There was no competition between individuals or grades although prizes of participation were awarded to each school represented. Good press coverage and cooperation with Parent-Teacher Associations made the open house a center of community interest. It provided an opportunity for the community to see



Area science coordinator demonstrates the use of science equipment to fifth-grade teachers.

what is being done in science education at all grade levels.

Evaluation of the Area Coordinator Program

Results are summarized of the project at the end of the first year:

1. Aroused interest and activity in science education at all grade levels.
2. Development of elementary science education leadership in individual faculties. (Most of the schools worked with now have a member of the faculty as a science resource person. These are teachers who had ability and interest in this area and who now have the stimulus and support of the coordinator in exercising positive leadership with their own faculty.)
3. Achievement of greater quantitative (and perhaps more important,

Use of microprojector is explained by area coordinator to seventh-grade teachers.

NORFOLK COUNTY PUBLIC SCHOOLS, VA.



greater qualitative) use of the equipment and materials available to science education. (Many elementary teachers were either unaware of the materials available or uncertain as to their use.)

4. Stimulation of professional growth among elementary teachers. (Several teachers enrolled in an elementary science methods course offered in extension.)

5. Increased confidence on the part of seventh-grade science teachers following the special workshop series.

6. Provision of science experiences suitable for all levels of achievement at all grade levels.

7. Encouragement of student project activity and development of desirable attitudes and interests in science at early grade levels.

8. Identification of science talent and interest early in school program.

9. Professional growth of the coordinators themselves.

Some weaknesses in the program were also observed. The personalities of the coordinators are important to success of the program. The use of tact and an attitude of "How can I help you?" rather than "I have come to help you" was found to be very important in some cases. Not all teachers desired assistance while others desired too much. The need of a curriculum guide with scope and sequence became apparent, and it is anticipated that one will be developed as an outgrowth of the in-service training mentioned above.

Conclusion

The area coordinator plan as a method of science supervision for a school community has definite advantages and strengths. It utilizes the experience and talents of several individuals. It assures more opportunity for service to the many schools in larger systems. Local schools are working with a person they know in the community rather than someone from the "main office." The coordinator, as a high school teacher, learns firsthand about the background and experiences of his future students and identifies early some of his prospective talented science students. Teachers, students, and the coordinators can benefit from the program.

Support for continuance and expansion of the program in the coming school year is evidence of its acceptance as a successful project.



NORFOLK COUNTY PUBLIC SCHOOLS, VA.

Eighth-grade science class receives instructions from area science coordinator, A. B. Niemeyer.

Essentially, as in other activities, leadership is combined with teamwork. These two combinations produce results which are of ultimate benefit to the progress and development of any school program, large or small.

Senior High School Weather Station

(as supplied to Pennsylvania high schools under N.D.E.A.)

#111 Max-min Thermometers

#257 Hygrothermograph

#503 Rain Gage

#210 Sling Psychrometer

#504 Rain Gage Support

#280 Slide Rule

#306 Barometer

#409 Windmaster

#351 Barograph

#176 Shelter

\$550.00

SCIENCE ASSOCIATES, INC.

194 Nassau St.

P.O. Box 216

Princeton, N. J.

Write for complete catalog



TESTA MICROSCOPES are designed and priced to provide the greatest number of quality instruments for a given budget!



K-21



K-34

For High School and College

Testa "Model K" Microscopes have many special features usually found only on much more expensive research instruments. 12x Huygenian eyepiece. Color-coded parfocal objectives. Extremely precise fine focus. Helical rack and pinion. Automatic adjustable safety stop. Large professional 90° tilting stand with bumper toes to protect stage and objectives.

MODEL K-21. Double revolving nosepiece. 10x and 45x parfocal color-coded objectives. 120x to 700x magnification. 6-aperture diaphragm disc. **\$94.50**

MODEL K-34. Triple revolving nosepiece. 10x, 18x, and 45x parfocal color-coded objectives. 120x to 700x magnification. Includes illuminator, condenser, and iris diaphragm. **\$116.00**

FOR NATURE STUDY

Study live insects and whole specimens with **WIDE-FIELD MODEL A**

No slides to prepare! ...with this rugged, full-size microscope. Features large working distance and 15x, 45x, and 75x magnification. Unusual versatility. 360° inclinable arm. Kellner-type eyepiece. Triple divisible objective. Large reversible black and white stage.



\$54.85

Start their interest in Science early . . . with the **TESTA S-3**

This sturdy, full-size instrument is ideal for beginners. It is equipped with the basic components of standard compound microscopes. 10x Huygenian eyepiece. 75x to 250x magnification. Double divisible color-coded objectives.



\$39.85

TESTA G-4 . . . ideal for elementary biology

Standard-size compound microscope provides variable magnification from 100x to 400x. Makes teaching easier . . . students learn faster. Triple divisible color-coded objectives. 6-aperture diaphragm disc. 12x Huygenian eyepiece.



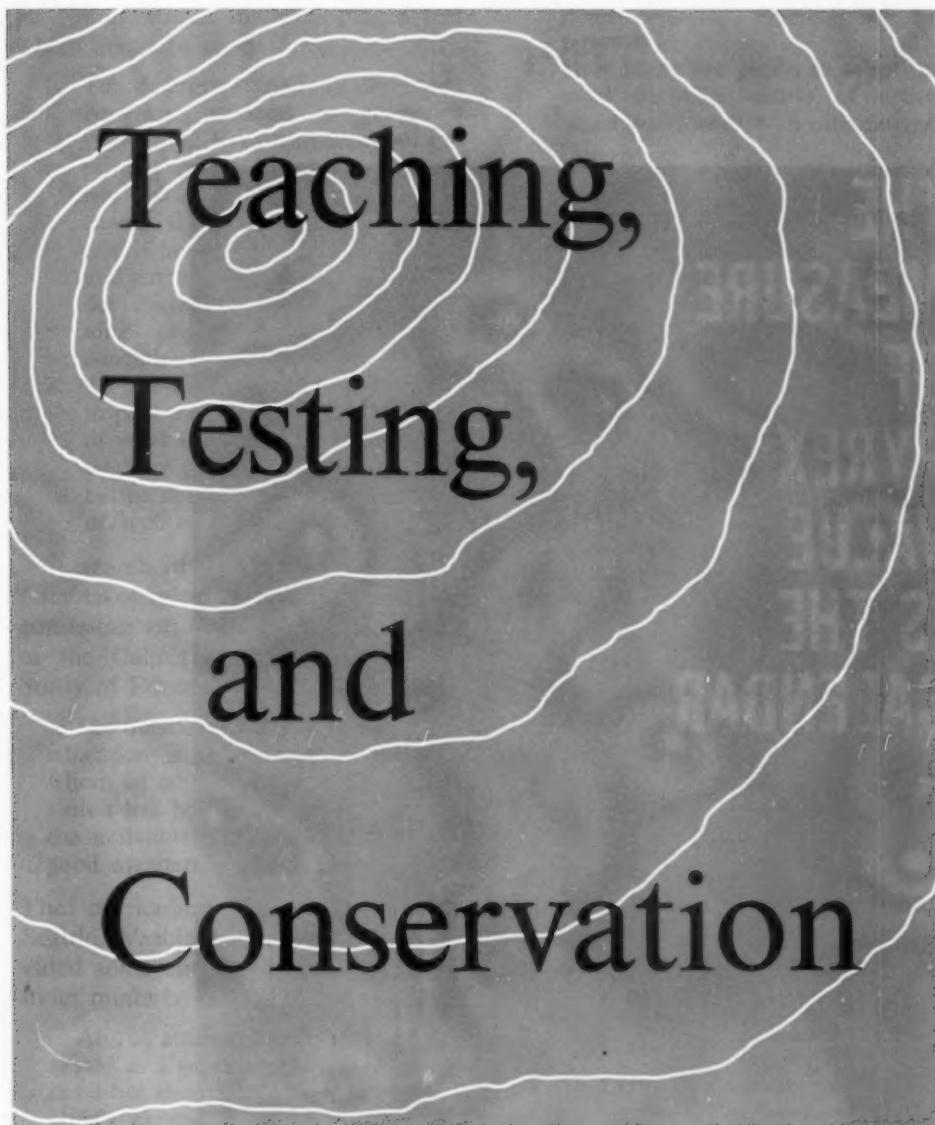
\$64.50

Quantity Discounts to Schools

TESTA MFG. COMPANY
Dept. ST4—10126 East Rush Street—El Monte, California

Write for Catalog on complete line





Teaching, Testing, and Conservation

By SIDNEY L. BELT

Science Section, Educational Testing Service, Princeton, New Jersey

Well-constructed objective tests should not be overlooked as a valuable source of ideas in curriculum planning and classroom teaching. The Conservation Foundation's recently developed "Test of Reasoning in Conservation" is one of these sources.

THE teacher, in the normal pursuit of his profession, is called upon to make many judgments of far-reaching effects on the educational progress of his students. Of particular significance are judgments regarding what objectives to work for, what content to use, and what methods to select. In making these judgments, the teacher is assisted by published aids, ranging from teaching outlines and lists of important con-

cepts and understandings in a field, to complete sets of daily lesson plans. One source of ideas for curriculum development which should not be overlooked is the questions contained in well-constructed, published objective tests.

What features of well-constructed objective tests permit them to serve this function? For one thing, such tests probe those topics and outcomes which experts consider important. Teachers

find it helpful to compare the professional judgment of the test authors with their own in arriving at decisions regarding objectives and content.

Secondly, a well-constructed test rewards the student who has real understanding rather than the one who is capable only of empty verbalization. Let us examine this difference in the light of the actual teaching situation by quoting the now classic story of William James:

A friend of mine, visiting a school, was asking to examine a young class in geography. Glancing at the book she said: "Suppose you should dig a hole in the ground, hundreds of feet deep, how should you find it at the bottom—warmer or colder than on top?" None of the class replying, the teacher said: "I'm sure they know, but I think you didn't ask the question quite rightly. Let me try." So, taking the book, she asked: "In what condition is the interior of the globe?" and received the immediate answer from half the class at once: "The interior of the globe is in a condition of igneous fusion."¹

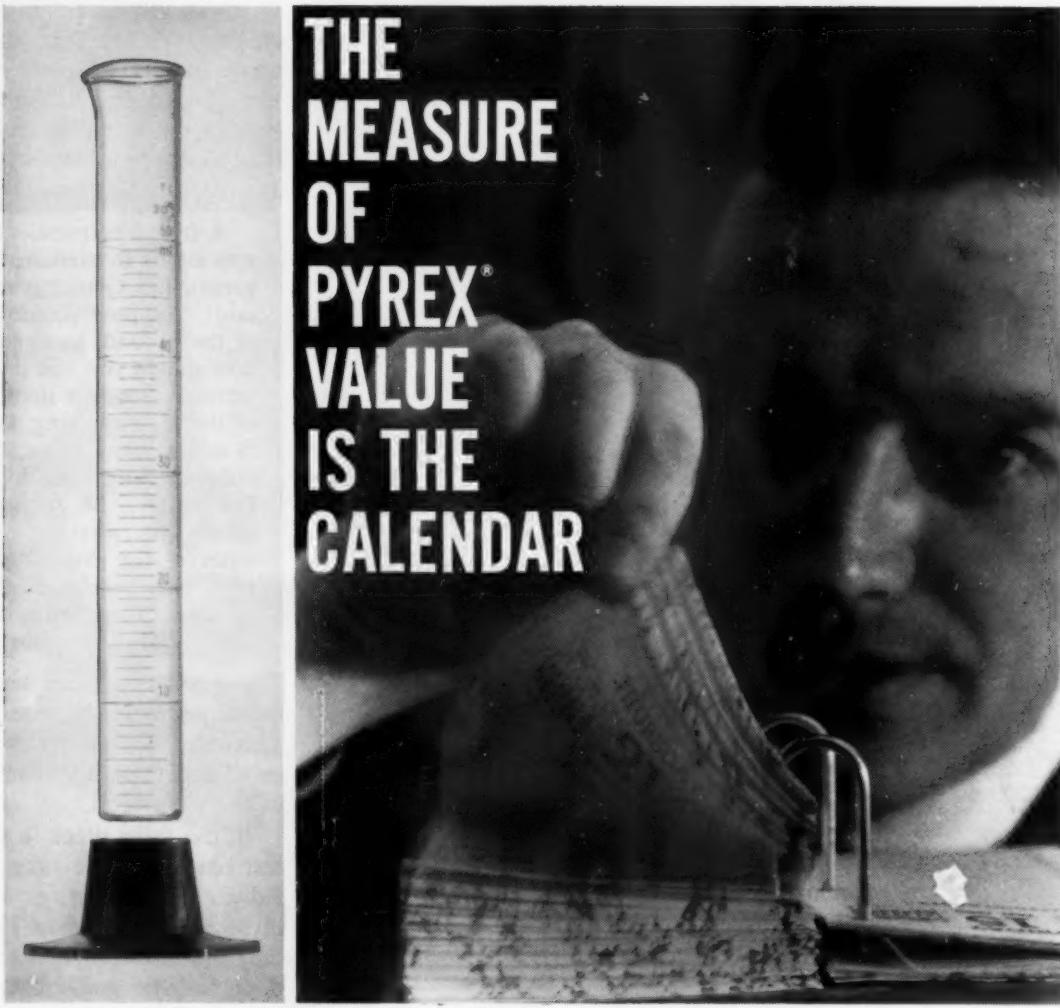
The good objective test, by framing questions to probe true understanding, provides the teacher with models of how understanding can be cultivated in the classroom.

In the third place, a good published test covers a wide range of objectives. Educational objectives are often stated in terms so nebulous or ethereal that they more nearly represent pious hopes than realistic guideposts. The teacher, pressed for time, may be unable to relate such objectives to actual learning situations and may settle for mastery of information, trusting to luck that the relations to abstract goals will somehow be established. If the teacher can see that a particular outcome is measured in a test, however, he may be enabled to teach toward it directly.

The Test of Reasoning in Conservation

In order to illustrate more fully how good testing and good teaching are interrelated, let us consider the construction of a particular objective test in terms of both the specific purposes of the test and the particular nature of its subject-matter area. At the end of 1957, the Conservation Foundation called upon Educational Testing Serv-

¹ William James, *Talks to Teachers on Psychology and to Students on Some of Life's Ideals*. Henry Holt and Company, Inc., New York. 1899. p. 150.



*Consider
the
student
cylinder*

Made to last. To take student use. And abuse. To go to work again next year.

Its base is plastic. Unbreakable. Hexagonal. Can't tip. Can't roll. Its cylinder is thick. Tough. Hard glass. Extra heavy bead and pour-spout. Its glass is PYREX brand No. 7740. We can make it thicker without losing the ability to stand up to the thermal shock of either

See Supplement 3 to Catalog LG-1. If you don't already have a copy, write to 77 Crystal Street, Corning, N.Y.

flame or exothermic reaction.

You have to know students and labs well to design ware like this. We know students and labs well. Been working with both for a half century.

Whenever you put together an order, check our prices and quantity discounts (as much as 23.5%) and see how economically you can buy PYREX value and safety.



CORNING GLASS WORKS
CORNING MEANS RESEARCH IN GLASS

PYREX® laboratory ware...the tested tool of modern research

ice for assistance in developing a test which could be used:

1. To determine periodically what American students in grades 9 through 12 have learned about important aspects of conservation. It was felt that such surveys would enable the Conservation Foundation, when called upon by teachers and curriculum committees, to render maximum assistance in planning programs of conservation education.
2. To provide classroom teachers who inspect the test with a clear picture of what specialists and experienced teachers of conservation believe to be the desired scope and objectives of such education.

A search of the literature yielded a number of relevant statements. A subcommittee on Conservation Education of the California Committee for the Study of Education had this to say:

The outstanding aim of conservation education is to develop a people in whom an attitude and spirit of conservation has become as much a part of the individual personality as courtesy, good manners, honesty, and thrift.²

The curriculum department of the Seattle, Washington school system provided some clues as to how such attitudes might be related to behavior:

An . . . attitude should never be presented as a generalization to be memorized but should be an outgrowth of a child's experience, study, and discussion—the result of inductive study of a situation. Real learning is that which is part of behavior. Our concern is not only with what children know—but how they feel. Facts are sterile things unless opinions and conclusions grow out of them; understandings and opinions are barren unless behavior is influenced.³

It was felt that the dual objective of the Conservation Foundation would be achieved by a test designed with these questions as guides:

1. What are the essential facts and concepts that are being learned by the pupils?
2. To what extent are pupils aware of the implications of these essential facts, concepts, and principles for

² *Guidebook for Conservation Education*. California Department of Natural Resources and Department of Education, Sacramento, California. 1950. p. 3.

³ *Using Our Land Wisely—A Resource Unit for Intermediate Grades*. Seattle Public Schools, Curriculum Department, Board of Education, Seattle, Washington. 1948. p. 8-9.

themselves, for society, and for posterity?

3. How likely are pupils to select the most desirable course of action when confronted with alternatives?

Problem-Solving Sets

Since the last two questions are relatively more important than the first, the selection of types of test material to be utilized was in large part determined by their relative effectiveness in yielding valid answers to the last two questions. Problem-solving sets appeared to be one indicated testing technique. In these, either a brief description of a situation or graphic material involving a problem in conservation is presented. Test questions related to the material presented are then designed to: (1) test for an essential fact, concept, or principle; (2) probe the understanding of the implications of various facets of the problem; or (3) allow the pupil to indicate a preference for various solutions or courses of action. Emphasis is placed mainly on the latter two categories.

To determine whether or not a problem-solving set meets these specifications requires more than a cursory glance. Mere format conformity does not qualify a sequence of testing material as an appropriate problem-solving set. Indeed, in the final analysis, it is the skill and creativity of the question writer and not the item type *per se* which contributes to the effectiveness of the question. Consider the following two sequences which draw upon the same basic material.

Set A

Read the following paragraph carefully and answer questions 1-3.

In some communities sewage is dumped directly into streams where it is disposed of by bacterial actions and by the dissolved oxygen in the water slowly oxidizing it. However, fish and the higher plants of the stream die; and only a few bacteria and algae remain alive in the polluted stream. Other cities dispose of sewage by running it into closed sludge tanks and allowing bacteria to decompose it into nitrogen, methane, and a humus-like waste.

1. Sewage in streams is disposed of by
 - (A) force of the running water
 - (B) action of bacteria and algae
 - (C) action of fish and higher plants
 - (D) oxidation and bacteria

* Denotes the correct answer.

2. The fish and higher plants soon die because

- *(A) they lack a supply of oxygen
- (B) they get too much nitrogen
- (C) the bacteria decay them
- (D) the algae reproduce too rapidly

3. Waste from sludge tanks

- (A) is used as lime
- *(B) is used as fertilizer
- (C) must be burned
- (D) must be buried

Set B

Read the following paragraph carefully and answer questions 4-6.

The sewage of city A is dumped directly into streams where it is disposed by bacterial action and by the dissolved oxygen in the water slowly oxidizing it. City B disposes of its sewage by running it into closed sludge tanks and allowing bacteria to decompose it into nitrogen, methane, and a humus-like waste.

4. The main advantage of disposing of sewage by dumping it directly into streams is that

- (A) it takes less time than using sludge tanks
- *(B) it saves the cost of sludge tanks
- (C) wastes are quickly removed from the vicinity of the city
- (D) harmful bacteria are quickly destroyed by sunlight and running water

5. Of the following, the main advantage of disposing of sewage by running it into closed sludge tanks is that

- (A) the waste from sludge tanks can be used for fertilizer
- (B) important minerals can be saved
- *(C) the open streams are kept safe for recreation
- (D) the sewage disposal plant provides gainful employment for a number of people

6. In comparing the methods used by cities A and B in disposing of their sewage one should realize that

- (A) both methods are equally good
- (B) both methods are equally bad
- (C) the method used by city A is better
- * (D) the method used by city B is better

Set B comes closer to qualifying as the desired type of problem-solving set than does Set A. Note that question 1 of Set A tests reading comprehension. Although question 2 tests an important conservation concept and question 3 an important fact of conservation, the

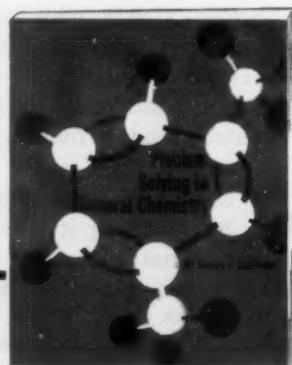
pupil is not called upon to weigh implications or to select among courses of action. In set A we also observe that the options draw only upon purely scientific material, ignoring the impact of economic factors on conservation practices presented in Set B.

No. 4 of Set B, by presenting a practice undesirable for conservation without commenting on its undesirability, tacitly compels the student to weigh implications both biological and economic. Since the obvious answer for No. 5 (the effect of stream pollution

on human health) is not listed, the student is required to weigh the alternatives presented and, by selecting from among these reasons, all valid, to reveal his scale of values pertaining to conservation. No. 6 calls on the student to make a value judgment as to courses of action. To be sure, No. 6 merely probes recognition of the desirable course of action and we have no assurance that the student would actually behave (e.g., in the voting booth) in accordance with the point of view expressed in his response. On the other hand, who

would deny that recognition of correct courses of action is requisite to appropriate behavior?

The kind of reasoning which prompted the development of Set B instead of Set A is quite similar to the reasoning followed by the competent teacher in planning and carrying out his teaching. For example, teachers realize that presenting their students with a list of "do's and don'ts" does little to develop any growth in ability to make wise decisions. Teachers attempt to bring about this growth by exploring with their students the various factors that impinge upon a problem. They then arrange for the students to weigh the implications of the various courses of action. Only then do they call for a value judgment, if they feel that such a judgment is appropriate. By being involved in such a procedure, the student acquires a general appreciation that problems are often complex and that oversimplified answers can be misleading. In addition, the student acquires an arsenal of facts and concepts which are available for future use—available because they have been experienced in a meaningful context he can understand and appreciate.



To help your
student "see
through" and
solve chemistry
problems on
his own

Problem Solving in General Chemistry

by George I. Sackheim

- Provides the high school student with groundwork in the mathematics of chemistry.
- Offers complete step-by-step instruction on how to solve chemistry problems.
- Makes a clear explanation of concepts that are the most difficult for students.
- Contains over 1100 examples and problems for the student to solve.
- Develops the ability to "think-through" problems rather than rely solely on memorizing mathematical formulas.

Here is a book that students in general chemistry will find invaluable for learning to make chemical calculations. With vigor, clarity and thoroughness, it shows how to solve a chemical problem; and it explains all the important concepts such as atomic structure, valence, nomenclature, and others.

Among its significant features is the General Mathematical Review found in Chapter 1. This chapter covers areas that serve as a springboard to a sound understanding of the mathematics of chemistry. The book is complete with necessary tables and charts. And answers to all problems are contained in a separate 16-page Answer Book available to teachers on request.

Row, Peterson and Co.
Evanston, Illinois

Elmsford, New York

Problem-solving sets, then, provide teachers with hints as to how specific topics might be placed in meaningful contexts. They also suggest a variety of contexts which might be used. Below is a set which suggests that topics discussed in the mass media might be exploited profitably.

The following letter appeared in a local Colorado newspaper:

Dear Editor:

In last Tuesday's editorial you showed how much control the government had by telling the businessman how to run his business. Well they sure stick their nose in my husband's business. My husband is a cattle rancher and he grazes several hundred head of sheep and cattle on a nearby national forest range. For this "privilege" he pays the government a monthly fee for each head. The government tells my husband every year how many head of cattle he will be allowed to graze on the national forest range that year. Not only that, but he has to keep his herds on the move. What I want to know is, what right has the government to tell my husband how many cattle we can have, especially when we pay for each head? And besides, what right has the

government to charge us for using nearby land that is not being used for anything else?

Yours truly,
A rancher's wife

1. Should the government have the right to charge ranchers for using the national forest range?

*(A) Yes, because the national forest range belongs to all the people
(B) Yes, because the government had to buy the land originally from private owners
(C) No, because the national forest range should be free to all
(D) No, because the national forest ranges have been established for the people living in the vicinity
2. Why is the rancher required to keep his cattle on the move?

(A) To ensure that all the ranchers will have an equal share of the range
(B) To prevent the spread of cattle disease
*(C) To prevent the grass from being eaten too close to the ground
(D) To improve the quality of the meat
3. Which of the following factors is most important in deciding how many animals should be allowed to graze each year?

(A) The amount of livestock disease in the area
(B) The present price of livestock and grain
(C) The present availability of skilled help and the cost of transportation.
*(D) The condition of the range forage plants

Here again we see the strategy which might be employed by a successful teacher in giving his students experience in interrelating facts and concepts. Note, for example, that the second question has to do essentially with "overgrazing." However, in order to answer the question correctly, real understanding is necessary. In contrast, the following question requires only that the pupil remember a verbal generalization.

Which one of the following is the most important principle of grassland conservation?

- (A) Frequent burning of the grasslands
- (B) Permitting only sheep to graze

- (C) Prevention of overgrazing
- (D) Prevention of grazing of all kinds

Not all the questions in the *Test of Reasoning in Conservation* are parts of such sets. But all of the questions test aspects of the subject which are considered essential and which have important implications. The teacher would do well, therefore, to explore the ramifications of such individual questions as the following:

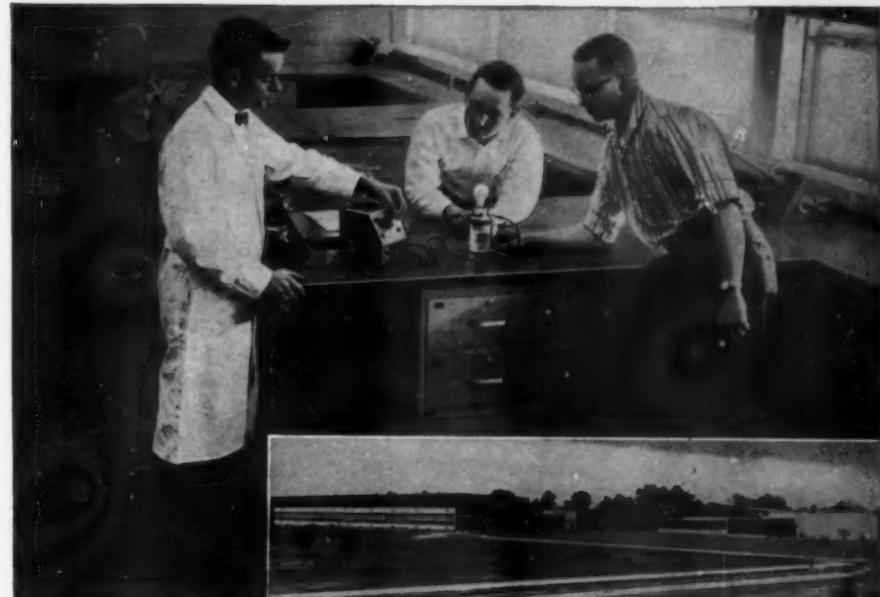
The United States, with less than 10 per cent of the world's popula-

tion, uses approximately what per cent of the world's production of minerals?

- (A) Less than 10%
- (B) Approximately 20%
- *(C) Approximately 50%
- (D) More than 90%

This question tests for knowledge of the fact that the United States plays a disproportionate part in depleting the world's mineral resources. A logical inference is that we may be moving in a direction that will place our industrial machine in jeopardy and that will hold

BEST POWER SUPPLY for your present science facilities



TEACHING WITH *Lab-Volt*—William W. Bohn, science department head, inspecting student experiment on conductivity of fluids at Edison Township High School, Menlo Park, N.J.

"Variable electrical power for science experiments was not provided in our new high school," reports Bill Bohn, head of the science department at Edison High.

"We carefully examined all available means of supplying variable AC and DC current for educational purposes and found *Lab-Volt* portable units the only practical solution to our problem. No installation was necessary and we could simply 'plug in' wherever we needed complete AC and DC service."

"We now have *Lab-Volt* portable service for all science students and strongly recommend them wherever labs are without permanent AC and DC power appropriate for electrical experiments."

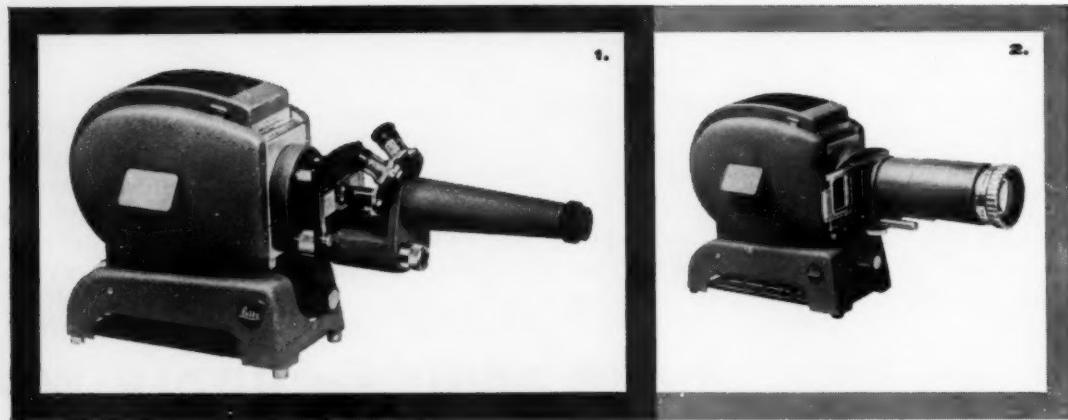
►FREE TEACHING AIDS . . . Sample illustrated experiments available on request.
Write for complete *Lab-Volt* catalog today.



BUCK ENGINEERING COMPANY, INC.

36 MARCY STREET, FREEHOLD, NEW JERSEY • FREEHOLD 8-1111

All models are U.S. approved.



switch in seconds { from projection of microscope slides to
projection of transparencies with the
LEITZ PRADO MICRO - PROJECTOR

The ultimate in convenience for use in classroom, conference room or lecture hall, the PRADO Micro-Projector delivers screen images of unrivaled brilliance, clarity and definition. With Micro Attachment it produces magnifications up to 2400x on screens at a distance up to 40 feet; with a film slide carrier and lens inserted, the PRADO projects 2" x 2" or of 2½" x 2¾" transparencies. And you can switch from micro to film slides in seconds—easily. The revolving nosepiece of the Micro Attachment holds three objectives: 3.5x, 10x and 25x. The high power objective is equipped with spring-loaded mount. Micro attachments are available which allow the stage to be placed in a horizontal position to accommodate wet mounts.

Light from the 500-watt lamp is projected through aspheric condensers in the PRADO, which is blower-cooled.

The PRADO Micro-Projector is portable, and may be carried easily from room to room and used wherever there is an electrical outlet.

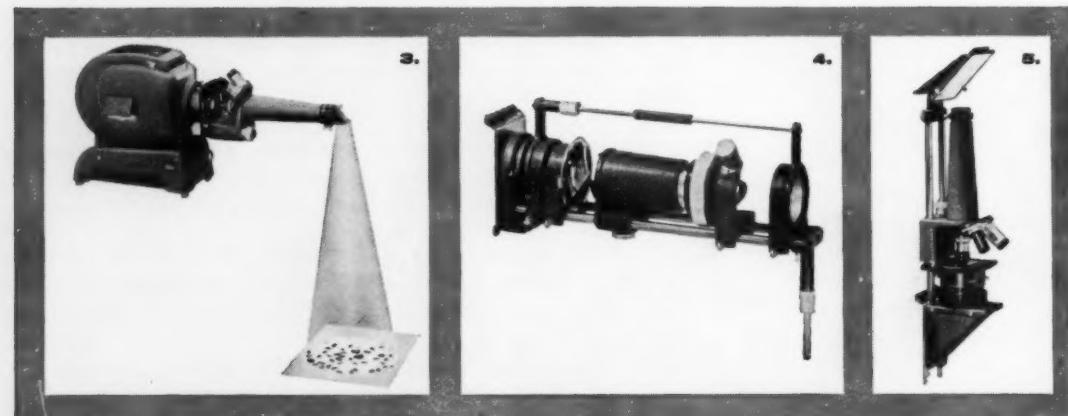
For illustrated PRADO Micro-Projector Brochure, write to Dept. ST-4.

- 1. PRADO as Micro-Projector for microscopic slides
- 2. PRADO as standard projector for film slides
- 3. Attachable reflecting prism for tracings
- 4. Polarizing Attachment for polarization demonstration
- 5. Large Vertical Micro Attachment for wet mounts



E. LEITZ, INC., 468 FOURTH AVENUE, NEW YORK 16, N.Y.
Distributors of the world-famous products of
Ernst Leitz G.m.b.H., Wetzlar, Germany—Ernst Leitz Canada Ltd.
LEICA CAMERAS • PROJECTORS • LENSES • MICROSCOPES • BINOCULARS

32459



serious implications for our standard of living as well as for our survival in time of conflict, economic or military. Information of this nature, even though it might not be presently emphasized in the curriculum, can readily be incorporated by the alert teacher. These illustrations may shed light on some of the ways in which well-constructed tests can contribute to effective teaching.

But good tests not only provide guides for teachers, they also provide guides for learners. Students in general plan their work and adjust their study habits in accordance with the kind of tests they anticipate. If a teacher who strives for the development of understandings is forced to utilize measurement instruments which emphasize only memorization of facts, his students will soon come to study accordingly. In short, students tend to learn what tests tell them they are expected to learn. Tests which foster worthy objectives deserve our best efforts since their influence upon the entire learning process can be of such inestimable benefit.

A Cooperative Effort

The impression may prevail that a published objective test is the work of a single expert who thus imposes his own value judgments on classroom teachers. No doubt some tests are constructed in this way. However, successful test development undertakings are more often characterized by the collective effort of many people, including test specialists, classroom teachers, and students. The development of the Conservation Foundation's test illustrates this cooperative approach.

During the initial stages of the project, a number of informal meetings were held between members of the staffs of the Conservation Foundation and Educational Testing Service. These conferences resulted in a document which contained a statement of the purpose of the test, a tentative list of the "Basic Understandings and Concepts in Conservation," a subject-matter outline, and some sample test questions. The document served as the basic guide for ten classroom teachers, representing a wide geographical distribution, who wrote test questions. Test questions were reviewed and edited by staff members of Educational Testing Service and the Conservation Foundation and assembled into pretests. Each pretest was administered to at least 300 ninth and

tenth graders. At the same time each pretest was being reviewed by at least twenty classroom teachers or other educators. From the teachers and conservation specialists, judgments were sought on the importance of the topics presented and on the effectiveness of the method of presentation. It was expected that performance would reveal ambiguities which might otherwise have gone undetected; that is, the review by teachers and specialists was to pass judgment on the significance of the *content*, whereas the tryout on the students

was to pass judgment on the *communication* aspects of the questions.

On the basis of pretesting and reviews, questions were again revised and assembled into three 40-minute final forms. Each final form was again reviewed by some twenty classroom teachers and conservation educators. These final forms were made available on a limited experimental basis during the 1959-60 school year. Published forms will profit from these tryouts. From inception to conclusion the project has required almost three years.

DUTTON SALUTES SCIENCE

LET'S GO FLYING by Martin Caidin

A comprehensive handbook for all who would like to fly as well as for those who do, packed with advice and information on methods of flying, air safety, communications and even how to buy a used craft. With appendices, photos and drawings. \$3.95

THE SPACE ENCYCLOPAEDIA by Sir Harold Spencer Jones et al.

The immensely valuable guide to astronomy and space research, completely revised with large additions and alterations to the articles on artificial satellites and planetary probes, missiles, the earth's atmosphere, magnetism, electrojets, etc. With over 300 photographs, maps and diagrams and with comparative tables of rockets, missiles and satellites. \$6.95

CAREERS AND OPPORTUNITIES IN CHEMISTRY: A Survey of All Fields by Philip Pollack

A fascinating survey of the new types of chemical discoveries, the nature of the work done by modern chemists and the tremendous new job opportunities they create. Qualifications, educational requirements and salary levels complete this thorough analysis. Photographs. \$3.75

AVIATION IN THE MODERN WORLD: The Dramatic Impact Upon Our Lives of Aircraft, Missiles and Space Vehicles. by James V. Bernardo

A full discussion of the history of man's conquest of the air, the principles of flight and its universal effect upon our lives, by an expert in air navigation education. With photographs, drawing and maps. \$5.95

NEW DIMENSIONS OF FLIGHT by Louis Zarem

A precise, complete and thoroughly researched account for young readers of our efforts and accomplishments in advanced aviation and space exploration. Clear explanations of the principles, concepts and vehicles involved and their commercial and military applications, with emphasis on the role of man in this dawning space age. Photographs and drawings. \$3.95

**300 Park Avenue South
New York 10, N. Y.**



GET YOUR FREE COPY

OF THIS NEW CENCO BOOKLET
A suggested outline for teaching elementary science with recommended apparatus.

Please send my FREE copy of ELEMENTARY SCIENCE APPARATUS—Booklet ES-6.

Name _____
Address _____
City _____ Zone _____ State _____

This helpful booklet provides a ready means of selecting, by subject matter, apparatus and materials needed to initiate or supplement elementary science courses. Apparatus listed meets the science enrichment intent of NDEA. Cenco equivalents of items described in the 1959 "Purchase Guide" are indicated.



Serving education since 1889.

CENTRAL SCIENTIFIC CO.

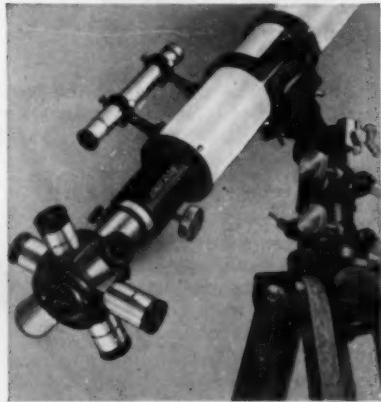
A Subsidiary of Cenco Instruments Corporation
1718-O Irving Park Road, Chicago 13, Illinois
Branches and Warehouses—Mountainside, N. J.
Boston • Birmingham • Santa Clara • Los Angeles • Tulsa
Houston • Toronto • Montreal • Vancouver • Ottawa

THE SKY IS THE LIMIT

The fiction of Jules Verne is rapidly becoming fact as the world begins to adapt to a new "space age". Satellites are now in orbit. Sending a rocket to the moon is under active discussion. Outer space travel is sufficiently close for the conducting of military experiments to simulate its conditions.

In teaching, there is a compelling need to give students an opportunity to do more than just read about the universe.

An astronomical telescope must be capable of resolving pinpoints of light at enormous distances. It, therefore, has to be designed specifically with that objective in view. Highly precise and matched optics are essential to obtain the crystal-clear image definition so necessary for astronomical observations to be meaningful. Mechanical mountings must also be built to close tolerances in order to accurately track a star or planet. You will find all of these requirements superbly matched in a UNITRON.



2.4-Inch ALTAZIMUTH REFRACTOR

MODEL 114—COMPLETE with Altazimuth Mounting and slow motion controls for both altitude and azimuth, tripod, 5X-16mm. viewfinder, rack and pinion focusing, 4 eyepieces (100X, 72X, 50X, 35X), choice of UNIHEX rotary eyepiece selector or star diagonal and erecting prism system, sunglasses, dewcap, dustcap, wooden cabinets, instructions..... \$125.

Biology

Cyclosis and Plasmolysis

By FRANK E. WOLF, State Teachers College, Fitchburg, Massachusetts

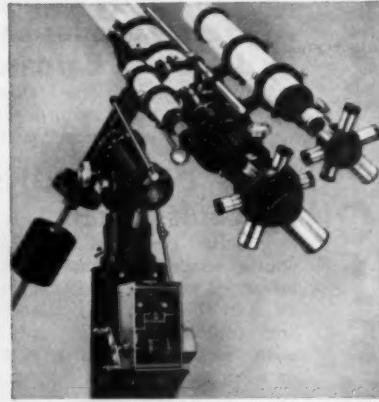
Materials: Student microscope, Elodea growing in strong light, hypertonic sodium chloride solution.

Procedure: 1. Place a young Elodea leaf on a slide in a drop of water, cover with a cover glass. If the plant has been in strong light for several hours, cyclosis may be observed. Under high power the protoplasmic movement will

be seen to cause the movement of the chloroplasts.

2. Withdraw the water from the preparation, using a paper towel or pocket tissue. Introduce a drop of the hypertonic saline solution. After a short period, observe the leaf toward the end away from the growing tip. Notice the shrinking of the cell membrane away from the cell wall. The protoplasm will condense toward the center of the boundary of the cell wall. Salt solution will occupy the space between the cell wall and cell membrane.

Discussion: Elodea is easily kept in a school aquarium and is a very useful



4-Inch PHOTO-EQUATORIAL REFRACTOR

MODEL 166—COMPLETE with Equatorial Mounting and slow motion controls for declination and R.A., setting circles with verniers, clock drive, metal pier, Astro-Camera, 10X-42mm. viewfinder, 2.4" guide telescope, rack and pinion focusing, 9 eyepieces (375X-25X). Super-UNIHEX rotary eyepiece selector, sunglasses, solar aperture diaphragm, UNIBALANCE, dewcap, dustcap, wooden cabinets, instructions..... \$1280.

UNITRON telescopes are America's largest selling refractors. They have withstood the test of time and are fully guaranteed. There are 16 models to choose from and easy payment terms are available.

Here is a selection of UNITRON Refractors:
1.6" Altazimuth \$ 75.00
2.4" Equatorial \$ 225.00
3" Altazimuth \$ 265.00
3" Equatorial \$ 435.00
4" Altazimuth \$ 465.00
4" Equatorial \$ 785.00
6" Photo-Equatorial with clock drive and Astro-Camera \$5660.00

This valuable 38-page Observers Guide and Catalog is yours for the asking! It will help you in the wise selection of a telescope suitable for your needs and at a price to fit your budget.

Contents include—

- Observing the sun, moon, planets and wonders of the sky
- Constellation map
- Hints for observers
- Glossary of telescope terms
- How to choose a telescope
- Amateur clubs and research programs



UNITRON

INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO.
204-206 MILK STREET • BOSTON 9, MASS.

Please rush to me, free of charge, UNITRON's new Observer's Guide and Telescope Catalog.
Name _____ Dept. 8-B.
Street _____
City _____ State _____

plant, not only for this demonstration, but in demonstrating photosynthesis and for collecting oxygen. It is possible to arrange this demonstration as an experiment. The problem to be solved would be: how may we determine that saline solution does, in fact, occupy the space between the cell wall and cell membrane? To answer the problem, allow the saline preparation to dry, and demonstrate salt crystals in the space in question, using a polariscope.

Chemistry

Quantitative Analysis

By RICHARD B. KENT, Foothill College,
Mt. View, California

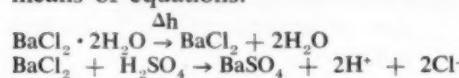
The following investigation was done during the summer of 1959, under the supervision of Dr. D. A. Skoog of Stanford University, and we believe that the following experiment should provide high school students with familiarity in some analytical procedures.

The conversion of barium-chloride-dihydrate to barium sulfate was picked for this experiment because of the low solubility of barium sulfate plus the high degree of accuracy obtained in a gravimetric determination.

Nature of Experiment

To determine the empirical formula for the stable hydrate of BaCl_2 .

To determine the percentage conversion of hydrated BaCl_2 to BaSO_4 by means of equations:



Materials Needed

1. Chemicals—distilled water, C.P. reagent HCl, C.P. reagent H_2SO_4 , and C.P. reagent $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$.

2. Equipment—weighing bottle, desiccator, spatula, analytical balance, drying oven (range 110–150°C) or air bath with burner, 400-ml beaker with 10-cm watch glass, glass stirring rod, graduated cylinder, medicine dropper, pipette or burette tube (volume 10–25 ml), hot plate, funnel (60°), ashless filter paper, crucible and lid, Bunsen

NOTE: The author completed eight years with the high school in Sandusky, Ohio, before changing to the present location. The study presented here was begun under a research grant from the National Institutes of Health in 1958.

or Tirrell burner, ring stand with ring, clay triangle, wash bottle, and indicator paper.

Procedure

Five per cent (5 ml H_2SO_4 /100 ml of solution) and 0.5 per cent (0.5 ml H_2SO_4 /100 ml of solution) solutions of sulfuric acid may be made up in advance by the instructor or students. A sufficient number of marked weighing bottles may also be cleaned and dried in advance and stored in a desiccator.

Students should obtain a weighing bottle and weigh it on the analytical balance to the nearest 0.1 mg. Following this, a small (0.5–1.0 g) sample of hydrated barium chloride is weighed into bottle to the nearest 0.1 mg and the sample containing bottle is then dried in an oven (110–150°C) for a period of one to two hours or over air bath for 30 minutes. Following this the bottle is allowed to cool to room temperature, within a desiccator, and again weighed to the nearest 0.1 mg. (Note: The loss of weight observed should be due entirely to the water of hydration since barium chloride does not decompose at temperatures involved here.)

The dried and weighed sample is then quantitatively transferred to a 400-ml beaker using approximately 100 ml of distilled H_2O to effect the transfer. One ml of concentrated HCl is added and then the solution is brought to a boil. (Note: Avoid spattering due to too rapid boiling.) Approximately 10 ml of hot, 5 per cent H_2SO_4 is slowly added to solution by means of a pipette or burette tube, stirring constantly. Precipitation of BaSO_4 will be noted at this time. Completeness of reaction can be tested by allowing beaker's contents to settle and adding one more drop of acid. If reaction is not complete, more precipitation will be noted.

Assuming reaction is complete, the beaker, covered with a watch glass, should be placed on a hot plate or steam bath and the precipitate allowed to digest for an hour or so. (Note: Avoid any vigorous boiling during the digestion period.)

A marked crucible, previously heated for 15–20 minutes with Bunsen burner and allowed to cool within desiccator, is weighed to the nearest 0.1 mg and returned to desiccator until needed.

A long-stemmed, 60°-angle funnel is prepared for filtration using ashless fil-

SEMI-MICRO FOR SCHOOLS



CENTRIFUGE

COMPLETELY SAFE
for student use.



Interchangeable cast aluminum head holds 10 x 75 mm tubes and 13 x 100 mm tubes.

No waiting—stop Centrifuge with slight palm pressure. Silent, ruggedly built for long life.

No. T 3080 Waco Separator for 100 volt 60 cycle.....\$47.00



SPATULAS

Only 24¢ each



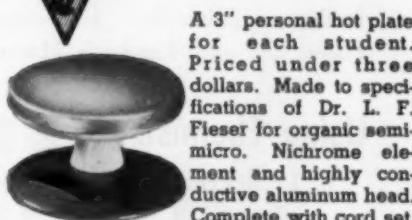
HAND FINISHED Spatulas perfectly shaped for semi-micro. Corrosion-resistant monel metal with a red plastic handle. Blade is slightly dished with a round bottom.

No. T 10115—Waco Spatulas, monel, 175 mm long, 23 x 5 mm blade tapered to 3 mm tip.

\$3.10 per dozen \$24.00 per 100



HOT PLATE



A 3" personal hot plate for each student. Priced under three dollars. Made to specifications of Dr. L. F. Fieser for organic semi-micro. Nichrome element and highly conductive aluminum head. Complete with cord set.

No. T 6612—Waco hot plate.....\$2.95



BURNER

Adjustable Natural and Mixed Gases.

Both gas and air are adjustable for full control of flame. Nickel-plated brass with flame stabilizer top. Takes 7/8 wing-top. Burner height 85 mm.

No. T 2627 Waco Burner\$1.80 each

Dozen or more.....\$1.60 each

WRITE FOR FREE SEMI-MICRO Catalog
No. T-4



ter paper, and the supernatant from the beaker is decanted off through the filter paper. The precipitate is quantitatively transferred to the filter paper, using a hot 0.5 per cent solution of H_2SO_4 for transfer and keeping transfer volume to a minimum. The precipitate is washed twice with small volumes of hot distilled water to remove all traces of acid ion. (Note: May be checked with litmus or hydron paper.) Final volume of filtrate and water should not exceed 200 ml.

Filter paper is carefully removed

from funnel, folded, and placed in the previously weighed crucible. The paper is then very carefully charred off with use of burner flame beneath crucible. (Note: Avoid combustion within crucible.) All remaining carbon is oxidized and the precipitate is then heated for 30 minutes within the crucible, with the crucible bottom attaining a cherry red glow at this time if the burner flame is properly adjusted. The crucible is then allowed to come to room temperature, within a desiccator, and weighed to the nearest 0.1 mg.

Calculations

1. Data necessary for determination:

- a. Weight of dry, empty weighing bottle _____ g
- b. Weight of bottle plus hydrate _____ g
- c. Weight of bottle plus anhydrous salt _____ g
- d. Weight of ignited crucible _____ g
- e. Weight of crucible plus dried $BaSO_4$ _____ g
- f. b minus a = weight of hydrated salt _____ g
- g. c minus a = weight of anhydrous salt _____ g
- h. b minus c = weight of water of hydration _____ g
- i. e minus d = weight of barium sulfate _____ g

2. To calculate empirical formula of the compound:

- a. Weight of Ba^{++} in sample = weight of barium sulfate (i) \times formula wt. of Ba $\overline{\quad}$ formula wt. $BaSO_4$
- b. Weight of H_2O in sample = weight obtained in 1-(h)
- c. Weight of Cl^- in sample = (f) minus (h) minus (2-a) (Hydrated salt's weight minus water of hydration minus weight of Ba^{++})
- d. Find gram-atoms of each component in compound
 - (1) gram-atoms of water = (h) $\overline{18}$
 - (2) gram-atoms of Ba^{++} = $\frac{(2-a)}{137}$
 - (3) gram-atoms of Cl^- = $\frac{(2-c)}{35.5}$
- e. Now x, y, and z in $Ba_xCl_y \cdot z(H_2O)$ can be evaluated by dividing each of the number of gram-atoms by the smallest of these.

3. To determine percentage conversion of barium chloride to barium sulfate:

- a. Weight of dried, ignited $BaSO_4$ obtained (1-i) _____ g
- b. Weight of $BaSO_4$ that should have been obtained $\overline{\quad}$ formula wt. $BaCl_2$ hydrate $\overline{\quad}$ formula wt. $BaSO_4$
 \times weight $BaCl_2$ hydrate started with (1-f)
- c. 3-a divided by 3-b gives percentage conversion _____ g

Conclusions

With reasonable care on the part of the student, he should be able to get good reproducible results and end up with an experimental determination of the empirical formula for the hydrated barium chloride crystal as well as a high percentage conversion of this hydrate to the insoluble $BaSO_4$.

Outstanding Books for Your Science Program

Chemistry for Our Times

Third Edition (1960)

by Weaver and Foster

Thoroughly revised to include all the latest developments. New emphasis on principles. A transvision of a nuclear power plant. New endpapers present relative atomic and ionic radii of representative elements. Many new illustrations. Each new topic begins with phenomena familiar to the student and moves on to related chemical facts and principles. Laboratory Manual, Test Booklet, Correlated Filmstrips, and Teacher's Manual available.

Using Chemistry

1959 Edition

by Oscar E. Lanford

A solid principles book, geared to the exacting standards of present-day science requirements. New material reflects recent developments. Emphasis throughout is on principles. Laboratory Manual, Test Booklet, and Teacher's Manual available.

Physics for Our Times, 1958 Edition

by Marburger and Hoffman

The Earth and Its Resources, 3rd Edition

by Finch, Trewartha, and Shearer

McGraw Hill Book Company

School Department

New York 36 • Chicago 46 • Dallas 2 • San Francisco 4

Remarks

Using the above procedure and apparatus, the author was able, over the course of many such determinations, to obtain an average value of 14.68 per cent for the water of hydration with an average deviation of 0.04 per cent thus leading to the correct empirical formula of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$. An average yield of 99.67 per cent with an average deviation of 0.24 per cent was obtained for the conversion of the hydrated barium chloride to barium sulfate.

We feel that an experiment, such as the one outlined above, might be of considerable value in the high school program when placed in its proper perspective. An attempt to evaluate this might include some of the following points:

1. There is a need, on the high school level at least, for the better student to be introduced to some of the quantitative aspects of chemistry. One of the greatest problems encountered in the high school laboratory is the relatively short working time in an allotted laboratory period. For this reason, we have attempted to break this experi-

ment up into several one-hour sessions, so that interested teachers might know how to plan their laboratory sessions. The experiment has been allotted a total of five hours with the thought that a group, working approximately one hour per day, might complete it in one week's time. The schedule is as follows:

First hour. Student cleans and dries his crucible, then places it in a desiccator until needed. He obtains a previously cleaned and dried weighing bottle from instructor and weighs it on the analytical balance. The sample may then be measured into his bottle and the new weight recorded. Sample is then placed in drying oven or on air bath and removed at the appropriate time by the student or the instructor, and placed in the desiccator until the following laboratory period.

Second hour. Cooled and dried sample is weighed again so that loss of water may be calculated, transferred to a beaker, dissolved in water, brought to a slow boil, and precipitated with previously prepared, hot 5 per cent H_2SO_4 . The beaker is then placed on a hot plate and allowed for the appropriate time



Now—a combination galvanometer, four-range voltmeter and four-range ammeter with figures and graduations on a large 17" scale that is plainly seen from both sides over any distance in the classroom. An accurate, versatile lecture meter with a modern, shielded movement. All parts and circuits clearly visible. Cenco No. 82140 complete with shunts and multipliers \$260.00

Serving education since 1883.

CENTRAL SCIENTIFIC CO.
A Subsidiary of Cenco Instruments Corporation
1718-O Irving Park Road, Chicago 13, Illinois
Branches and Warehouses—Mountainside, N. J.
Boston • Birmingham • Santa Clara • Los Angeles • Tulsa
Houston • Toronto • Montreal • Vancouver • Ottawa

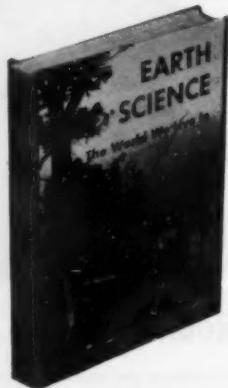
portable...Turner BUNSEN Burner

A convenient, self-contained Bunsen burner which requires no gas outlets or hose connections. Ideal for labs, classrooms, desk demonstrations and field labs, the TURNER BUNSEN BURNER furnishes clean, efficient heat instantly. Propane gas is contained in lightweight steel tank with safety valve. A variety of extra burner heads is available for specialized lab work. The TURNER BUNSEN BURNER costs only \$10.50, complete with cradle. Disposable replacement tank can be replaced in seconds, costs only \$2.10. From laboratory supply houses or direct from



TURNER CORPORATION • SYCAMORE, ILLINOIS

The Van Nostrand Science Program— unsurpassed texts for high school courses



EARTH SCIENCE THE WORLD WE LIVE IN

1960 edition Namowitz, Stone

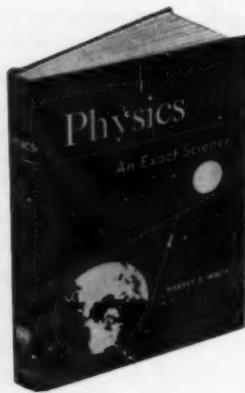
PHYSICAL SCIENCE A BASIC COURSE

1959 Hogg, Cross, Vordenberg



PHYSICS— AN EXACT SCIENCE

1959 White



SCIENCE IN EVERYDAY LIFE

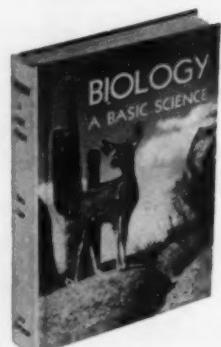
1958 edition

Obourn, Heiss,
Montgomery



BIOLOGY— A BASIC SCIENCE

1958 Heiss, Lape



For complete information concerning Van Nostrand texts in earth science, physical science, physics, general science, biology, or chemistry, write to the School Department.

D. Van Nostrand Company, Inc.

120 Alexander Street

Princeton, New Jersey

to digest, and then again removed by the student or instructor and allowed to cool.

Third hour. The student sets up his filtration apparatus, prepares his hot wash water and 0.5 per cent H_2SO_4 , transfers his precipitate quantitatively, washes it, and readies the filter paper for charring and ignition. The paper can be stored in a covered crucible until the next hour.

Fourth hour. The student chars off the filter paper and ignites the precipitate for at least 30 minutes. He then places the crucible in a desiccator to cool until the next hour.

Fifth hour. The student weighs the precipitate in the crucible and then makes his calculations.

2. Assuming that the high school chemistry laboratory has access to an analytical balance, this experiment would give the student a chance to either gain or demonstrate proficiency in the use of this balance, rather than merely being introduced to it with the statement that "Here is a tool used by chemists for accurate weighings, if they desire such."

3. The student's results, in such an experiment, regardless of his accuracy, should leave him with an appreciation for the detailed work necessary in a quantitative analysis.

4. The student actually uses methods for determining the empirical formula of a compound. Too often, this is done on a theoretical basis, in the classroom, with no actual physical processes involved and the student has no chance to correlate what he has learned with what he actually does in the laboratory.

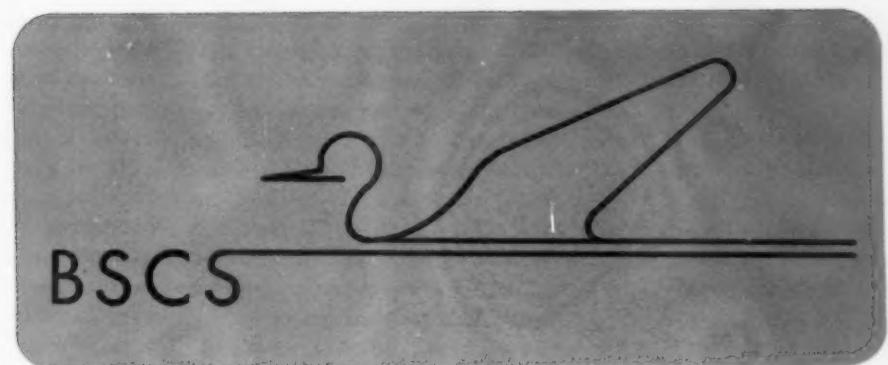
5. If the student does enough individual determinations, he gains an appreciation for the precision of his work and factors which may affect this precision.

6. There are many procedures involved in this experiment, e.g., quantitative transfer of a precipitate, ignition of a filter paper, digestion of a precipitate, etc., which will force the student to use reference books, and thus gain insight into new laboratory techniques.

AMERICAN COLLEGE BUREAU and FISK-YATES TEACHERS BUREAU

28 East Jackson Boulevard,
Chicago 4, Illinois

Leaders in nationwide placement service.
Member NATA



The **BIOLOGICAL
SCIENCES
CURRICULUM
STUDY...**

Its Organization, Plans, and Progress

THE Biological Sciences Curriculum Study, an educational project of the American Institute of Biological Sciences with major support from the National Science Foundation, had its origin in the conviction of many biologists in the United States that scientific curricula at all levels of instruction should be reviewed in the light of recent technical and scientific advances. When seen in broad perspective, it is obvious that there is an extremely wide range in the content and quality of biology offerings in our secondary schools and colleges. The amount and kind of teacher training, presentation of materials, physical facilities, and the role of biology in the total curriculum are all known to vary tremendously and it is no secret that much could be improved.

Biology has a real contribution to make to an understanding of society and to the expected direction of its evolution. But its role is not always well understood. It is important that every literate person understand what biology is. As a basic science it is an integral part of our present scientific revolution. It is not entirely medicine or agriculture. Though drawing upon chemistry and physics, it deals with more complex structures and organizations, and its level of major generalization is less well formulated and precise.

For most American secondary school students biology is the only science course that is taken. It is thus especially important that through bi-

ology the general student learns to appreciate the growth of scientific knowledge and acquires a conception of the basis of scientific thought. It is important that he has an understanding of his own place in the scheme of nature, and that as a living organism he has much in common with all other living things. He should develop an intellectual and esthetic appreciation of the beauty, drama, and tragedy of the living world, and an understanding of the biological basis of many of the problems and procedures in medicine, public health, and conservation.

Against and because of this background, the Biological Sciences Curriculum Study has the responsibility of developing an improved sequence of life science subjects in the schools and colleges; to make recommendations for the content of courses; to suggest effective methods of presenting these materials; to recommend appropriate placement of biology topics with respect to other courses in the curriculum; to explore special courses for exceptional students; and to design materials for both in- and pre-service teachers of biological sciences.

Plans for such an educational program in biology were developed over a three-year period by the AIBS Education Committee under the chairmanship of Dr. Oswald Tippo of the Yale University (New Haven, Connecticut) Department of Botany. All possible occasions were utilized to appraise biologists of these plans and to elicit suggestions from them. By January 1959, plans were sufficiently advanced so that the Biological Sciences Curriculum Study could be established. The program is being administered by a small staff with headquarters at the University of Colorado in Boulder.

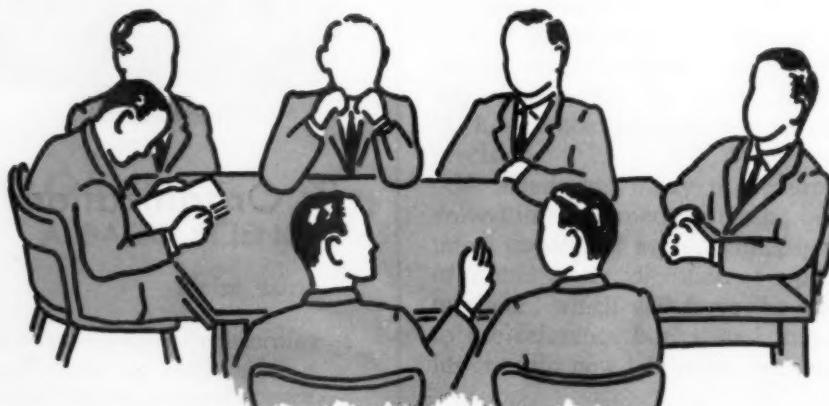
It is planned that the BSCS will eventually be involved in biological education at all levels. It was early recommended that the high school course be considered first, since this level is thought to be the most crucial one at the present time. It is anticipated that at a later date the Study will investigate elementary and college levels. Studies are also contemplated of improvements that could be made in biological education for the general public and some of its special groups. Because of the speed with which the sciences are changing modern life, biological education cannot simply be limited to students enrolled in schools. Moreover, many aspects of biological education are not restricted to classroom situations and supplementation is necessary. Investigations will thus be concerned with the potentialities in adult education, periodicals, books, newspapers, films, television, radio, museums, zoological gardens, National and State Parks, and various youth programs such as the Boy and Girl Scouts of America. The entire program, from the initial phases of information gathering, through analysis, testing, and final recommendations, should take several years.

The Committees and Their Responsibilities

The general policy of the BSCS is determined by a Steering Committee composed of twenty-seven members currently representing the following categories: professors of biology, high

school biology teachers, science supervisors, science educators, medical and agricultural educators, and university administrators. The chairman is Dr. Bentley Glass of Johns Hopkins Uni-

versity in Maryland. At the present time the largest single group on the Steering Committee consists of professional biologists, for it is felt that the design of a new curriculum in biology



should depend heavily upon those individuals who have an intensive knowledge of the various facets of the field of biology. Men working on the frontiers of the science have such a knowledge. It is intended that a greater proportion of in-service secondary school biology teachers will be recruited as the Study becomes more deeply involved in the production and implementation of curricular materials.

Dr. John A. Moore, Columbia University, New York City, is chairman of the Committee on Course Content which is designing a first course in biology for the secondary school level, since this is considered to be the pivotal area in American education today. It will also be important to determine whether additional courses, perhaps in the twelfth grade, are desirable for superior students, college preparatory students, and those with a special interest in biology as a career. A careful investigation of the biological content in junior high school general science courses will also be made.

It is important that this committee develop a course in which the nature of scientific inquiry, the intellectual history of biological concepts, genetic continuity, regulation, complementary structure and function, diversity, and many other similar important concepts are made clear to the student. Certain concepts dealing with the nature of science such as the quantitative approach, incertitude, esthetics, limits of knowledge, speculation, temporal parameters, dynamic systems, multiple variables, and others should form a woof throughout the fabric of the entire course, being presented again and again in a multiplicity of examples to emphasize their pervading nature.

The wealth of biological knowledge is obviously so extensive that the committee can select only a fraction for presentation in a year's course. The selection itself will be made with the full realization that only a few students will become biologists. For the majority the high school course in biology is a terminal experience in this field, and represents the only opportunity for the student to become conversant with an important facet of man's intellectual efforts. For a few, the course should also reveal the vocational possibilities for careers.

Because the BSCS Steering Committee feels that much current laboratory instruction in biology is less than in-

spiring, a Committee on Innovations in Laboratory Instruction has been organized. Dr. Addison E. Lee, University of Texas, Austin, is the chairman. In cooperation with a number of high school and college teachers this committee is evaluating the role of laboratory experience in high school biology and it is intended that two improved series of exercises will be produced. The committee is devoting most of its time to an experimental laboratory program in which approximately one dozen laboratory units, or blocks, are being developed. Each "block" is composed of a comprehensive unit of laboratory and field work which is complete in itself. A single unit, or block, will probably take the entire class a period of five or six weeks to finish. Each block will deal with the investigation of biological problems related to a particular area in considerable depth.

The relation of these laboratory blocks to the remainder of the course is very important. The committee is aware of the problems of time and available space in the average American high school. The block of thirty hours laboratory work plus thirty outside assignment hours will fit the available time during a six-week period of five class hours per week. To do this it must constitute the regular class work during that portion of the year. A single group of students would usually not take more than one block a year. This represents a valuable contribution to the science student and future citizen alike. Through an organized series of related laboratory experiences, in which there is real participation in scientific investigation, the individual develops an understanding of the nature of the scientific method and spirit. Such a fundamental objective could well monopolize the time of the course for one-sixth of the year. For those school systems in which, for a number of reasons, the block program is at present unsuitable, a separate subcommittee will produce an improved series of more conventional exercises and demonstrations.

There is a serious need for special programs for gifted and talented students and a special committee has been established for this purpose, with Dr. Paul F. Brandwein of Harcourt, Brace and Company, Inc., New York City as its chairman.

Of prime importance in any teaching

activity is the teacher. A highly qualified and representative group of people has been recruited to serve as a Committee on Teacher Preparation. Dr. Joseph J. Schwab, University of Chicago, Illinois, is the chairman. The members of this committee are well aware that the high school teacher, who needs to be a generalist and an interpreter of science, is usually taught in biology by men who are specialists and investigators. It is obviously important that the high school teacher understand the ways in which biologists accumulate knowledge of their science. Teachers should be appreciative and informed concerning the nature of the scientific enterprise. Unfortunately, this experience is typically gained only at the Ph.D. level. Provision is not normally made for such training at lower levels of instruction. Furthermore, few recommendations for alleviating this condition have been made. Most recommendations for teacher training in biology have been based on surveys of existing practices, with the result that one seldom finds such innovations in teacher education. Courses that satisfy certification requirements are frequently of little benefit to pre- or in-service teachers. Though courses such as the history and philosophy of science would be very valuable in improving the climate of high school science courses, they are not required for certification in any state.

Much of the criticism levied against the teaching of science today is related to the difficulty of encompassing the entire range of subject matter included in the field of biology. Redesign of existing in-service and pre-service courses is certainly part of the answer. Perhaps even more important, however, scientists must learn how to communicate their findings to teachers in understandable language, and to make these ideas available through less technical publications than are now available. To help satisfy this need the BSCS is considering the production of an extensive pamphlet series. We need a teacher-training program designed to accomplish the purposes for which biology courses should be taught—to turn out teachers with an understanding of science and of children.

A Committee on Publications under the chairmanship of Dr. Hiden T. Cox, AIBS, will supervise the publication of materials produced by the BSCS.

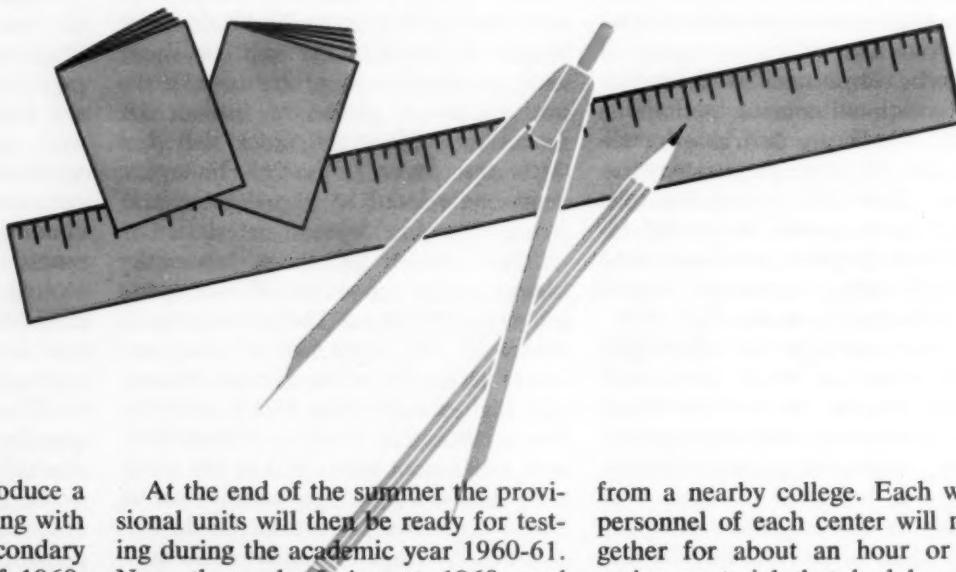
Consultants on Current Projects

Consultants for the Biological Sciences Curriculum Study are presently engaged in two separate programs. A number of high school biology teachers are generally recognized in their communities as being exceptionally effective. One program is concerned with the assembly and analysis of case histories and performances of a repre-

sentative group of these teachers with suitable controls. The consultant in this project is Dr. C. Francis Byers, formerly Assistant Dean of the College of Arts and Sciences at the University of Florida and now at Lewis-Clark Normal School in Idaho. The other program is the preparation of a digest of the vast literature on education in

biological sciences for the immediate use of BSCS committee members and consultants. It is planned to prepare a volume on biological education in the United States. This work is being done by Dr. Paul DeH. Hurd, presently located at the BSCS headquarters, who is on leave from Stanford University, California.

Curriculum Design



The BSCS intends to first produce a coordinated series of units dealing with biological science for the secondary school level. In the summer of 1960, a Writing Conference will be held to prepare an initial experimental series of text materials in the form of a number of units, extensive teachers' commentaries, and both block and more conventional laboratory exercises. During the Conference, the personnel of the present committees (Content, Laboratory, Gifted Student, and Teacher Preparation) will cooperate in teams constituted along subject-matter lines in accord with outlines prepared by the Content Committee. Thus, for example, there might be a team on evolution, one on genetics, one on developmental biology, and one on micro-organisms. Each team will be composed of approximately four high school biology teachers and four university biologists. Some of the latter will be members of present committees and they will be joined by other college biologists. Participants in the Writing Conference will also include science supervisors, editors, laboratory associates, educational psychologists, artists, and other specialized personnel.

At the end of the summer the provisional units will then be ready for testing during the academic year 1960-61. Near the end of August 1960, and after the Summer Writing Conference described above, a Teachers Conference will be held to acquaint the teachers who will be involved in testing experimental BSCS materials with the rationale underlying various parts of the course. Certain procedural matters concerning the materials will be described, which should help to orient the teachers about to embark on this new experiment.

The over-all plans for testing and revising these materials are as follows: Twenty testing centers located throughout the United States have been selected. Each center will include an active collegiate member of the 1960 Writing Conference. His position will be advisory. The chairman of each center will be a high school biology teacher who will be responsible for the local program. These high school teachers will have been participants at the 1960 Writing Conference.

Each center, then, will have a chairman, about four other local high school teachers of biology, and an advisor

from a nearby college. Each week the personnel of each center will meet together for about an hour or two to review material that had been taught previously, and to plan for the coming week. The center leader will be responsible for communicating to the BSCS office specific information about the strengths and weaknesses as they are uncovered in actual classroom use, or what other improvements are needed.

Thus, during 1960-61, the experimental materials will be in use by about 100 high school teachers (with perhaps 12,000 students) organized into about 15 centers. Of the 100 teachers, approximately 30 will have been members of both the Writing Conference and the Teachers Conference. The other 70 will have attended the Teachers Conference. Of the 15 center leaders, all will have been participants at the Writing Conference.

A staff member from the central office in Boulder will be able to visit each center in order to assist in the evaluation and collation of the materials for revision. Later, in the summer of 1961, it will be possible for a second Writing Conference to rewrite and restructure the units wherever the testing

program has indicated changes are necessary. During the academic year 1961-62 the remodeled preliminary units will be available to selected biology teachers who would like to try them experimentally with their classes, as well as at the official Testing Centers.

The summer of 1962 will be one in which a third Writing Conference will be involved in the production of final models for the secondary school biology courses. The models will be ready for general distribution and use during 1962-63.

At the present time it is anticipated that the biological materials for both elementary and introductory college levels will be developed under a similar plan, though these programs will lag approximately one year behind that for the high school level.

Cooperative Solutions To Problems

Many high school teachers are now giving good courses in biology. There is no reason why these individuals should feel any pressures for change, real or imagined, when final recommendations are made by the BSCS. There is at the present time perhaps too much of a trend to change for the sake of change without fully evaluating the programs concerned. The BSCS materials will be on the open market and can be adopted or not as seems best locally. There is no desire to promote a national curriculum. It is hoped that the biology courses that are finally recommended by the BSCS will be adopted completely on their own merits. The eventual success of the program seems assured by both the quality of the members of the working committees as well as through a rare enthusiasm which is truly infectious.

The Curriculum Study realizes that there are many problems associated with teaching effective science in the smaller high schools. At the present time there does not seem to be any ideal single solution to many of these problems. In a number of cases, better teacher preparation would do much to improve science instruction. This, and other important problems in science education, will require the attention of many experts and scholars both from within and without the BSCS. Major changes in science education will depend upon the cooperative activities of the various curricular studies, both

current and planned, as well as upon teachers, educators, parents, scientists, and administrators.

Small groups, such as the BSCS, can wield great influence, sometimes trigger widespread demands for reform. But the implementation of details for a new school curriculum, for improved professional preparation of teachers, and for the development of community support for the physical improvement of schools requires an uncommon degree of mutual understanding and cooperation by diverse groups interested in better science education. Furthermore, we must not expect betterment to come easily. Many of those interested in the improvement of biological science education recognize that the mere existence of the BSCS offers much promise, but, if necessary, they should also be prepared to make drastic changes from traditional educational patterns and local administrative procedures.

There are a number of important problems which must be, but have not yet been investigated by the BSCS. Two of these are (1) the proper interrelations of biology with the other succeeding or preceding science courses given at the intermediate and secondary school levels, and (2) grade level placement and development of biological concepts from kindergarten through grade 12. Related questions that must be considered by the various BSCS committees and other interested persons are: How can scientists representing all fields of biology best contribute to the development of an improved elementary school program in science? What aspects of the disciplines of biology should be given attention in the elementary school? Is the current pattern of a year of biology, chemistry, and physics in the senior high school satisfactory? Should there be a year of life science in junior high school?

The aspect of education in terms of human learning is an extremely impor-

tant one in view of a rapidly advancing technology. There is a fair amount of scientific information available on education which has not been utilized by practicing groups of individuals involved in instruction. Much of this information relates to the psychology of human learning, and thus is of considerable importance in curricular design. However, considerable additional research of an investigative nature must be brought to bear on many educational problems. One of the more important of these is the nature of human learning. Psychologists concerned with this field must be encouraged to conduct appropriate research so structured that their conclusions could be advantageously incorporated in the development of new courses of study. Cooperative activities between these individuals, or groups, and the various curricular studies is highly desirable. It is encouraging to see that cooperative efforts along these lines are being initiated at the present time.

Much work needs to be done in the area of educational media, for these are the vehicles of instruction. It is quite interesting that reliance on traditional and unproved educational methodology is slowly being broken down. In cooperation with psychologists, biologists must try to find out how lasting are behavioral changes in student attitudes when different media are exploited in biological science education. How quickly do these changes come about? The tremendous trend to automation through such devices as TV, films, and teaching machines will certainly cause us to look more closely at the role of the individual instructor in the biology classroom. A study of the gifted high school teachers by the BSCS is already underway; results of this investigation may provide the basis for improvements in teacher preparation.

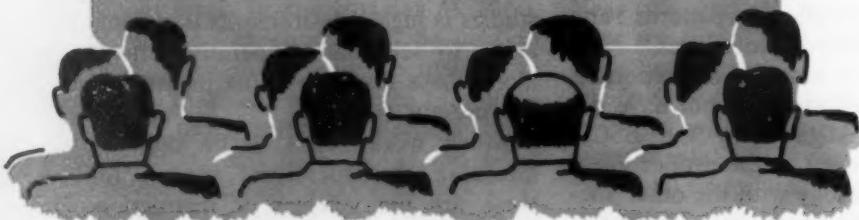
Relation of the BSCS to the Film Series

The relationship of the BSCS to the AIBS-sponsored Secondary School Biological Sciences Film Series has been confusing to some people. The program of the Secondary School Biological Sciences Film Series is to produce on film a modern treatment of classical and contemporary biology designed for the tenth grade. The Series will consist of ten major units of twelve films each. Thirty to forty additional

films are planned to supplement and extend the basic 120 films. The Series is not intended to replace the teacher, the laboratory, or field work, but rather to assist and to supplement them. Full production began in July 1959, and the basic Series will be available in either color or black and white. The thirty-minute films will be distributed by the McGraw-Hill Book Company and will be available singly, in sets, or

as an entire package. A teacher's manual and student's guide will be included in the Series which is being developed by more than a hundred university biologists and an equal number of secondary school biology teachers. The Film Series (described in the September issue of *TST*) and the Biological Sciences Curriculum Study are two separate AIBS projects aimed at improving biological education in America.

The AIBS and the Biological Sciences Curriculum Study



When the AIBS became an independent organization in 1955, the first standing committee that was established was the one on Education and Professional Recruitment. This action reflected the continuing concern of biological societies and the AIBS Governing Board with education in the life sciences. The charge to that committee was a simple one: develop a vigorous program of education at all levels which would become the basic policy of the Institute. Committee membership has been drawn from persons interested in biological education in universities, liberal arts colleges, land grant universities, high schools, and preparatory schools. Dr. Oswald Tippo, Yale University, has chaired the committee from its establishment.

At the first committee meeting in 1956 it was evident that the committee's major interest was in the improvement of course content and in the development of means to make the teaching of biology more effective. It was suggested that the AIBS sponsor an extensive course content study in the biological sciences, and the committee proceeded to develop an organizational framework for such a program. The proposal to establish the Biological Sciences Curriculum Study was approved as an AIBS project in 1958. In organizing the BSCS and the Film Series the AIBS has, in the minds of interested persons and cooperating professional organizations, come to be intimately identified with biological science curricular studies.

Sponsorship by the AIBS entails a number of advantages which will contribute to the success of the project. First of all, it indicates the deep interest of a group representative of the 80,000 members of AIBS. Through its various media and established contacts, the AIBS can facilitate communication between the Curriculum Study and the nation's biologists. Biologists are being informed of the progress of the Study, and there is resulting considerable feedback of opinions with suggestions and criticisms from the biological community. AIBS sponsorship greatly lessens the danger of imbalance that could more easily develop if the project were associated with a single university. Other interested groups are also kept informed.

Teacher Training . . . a Facet of the BSCS

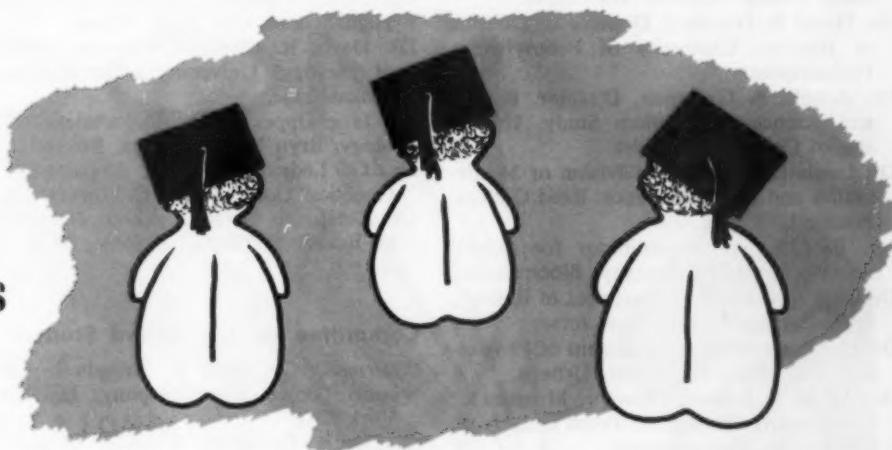
In order that the BSCS course, or courses, be successfully taught it is essential that teachers have opportunities to become substantially informed about the many modern developments in the life sciences. There are several ways in which this might be done. The BSCS high school biology course could be studied at in-service, summer, and academic year institutes. In addition, the BSCS plans to prepare extensive commentaries for teachers

along with the new secondary school unit materials. Still another approach under consideration is the production of a series of review pamphlets, each to be written by an appropriate scholar and devoted to a single topic in the life sciences. These pamphlets would be designed primarily for secondary school teachers, would be well illustrated and well documented. It is intended that they would be issued periodically and that they would be

revised as new developments emerge in the fields represented. In this way a high school biology teacher could readily build up an effective professional library giving him considerable depth in the many facets of the subject he is teaching.

Extensive teacher commentaries will also be produced to accompany the text materials and exercises constituting the BSCS recommendations for courses at all levels of instruction.

A New Generation Of Scientists and Their Responsibilities



A tremendous amount of work has already gone into the design of secondary school biology curricula at state and local levels. Much of it is good, sound, and solid. What is the justification then for this new effort by the BSCS, and what advantages over existing biology curricula may accrue from the Study? If there is a single important way in which the BSCS differs in its approach from these many independent studies which have been made over the years by high school faculty members, education faculty members, and state and urban education department staffs, it is that the BSCS involves the active participation of a large number of professional biologists who know the life sciences intimately through first-hand investigations. These biologists bring to the new biology curriculum an exhaustive store of modern knowledge, overview, and perspective that is available nowhere else in our society. The unique aspect of the BSCS is that

it brings to a cooperative team the special competencies of the biological scholars in our universities.

The present generation of scientists is beginning to cooperate extensively with teachers and educators as had been customary in the 1800's. There is an unprecedented activity today on college and university campuses where scientists are helping to develop new courses and bring recent developments into the classroom. Examples include the NSF summer and academic year institute programs and the teacher education and professional standards meetings. Biologists are taking an active part in such activities. Summer and academic year institutes, however, though extremely valuable, cannot by themselves introduce large-scale, coordinated curricular revision. That such revision is necessary seems evident.

We must constantly guard against the notion that because of the enormity of the problems associated with a cur-

ricular revision on a national scale, they cannot be surmounted. Questions we must ask ourselves are, "Is the planned program a good one?" "Is the recommended curriculum superior to that which is offered in our high schools at the present time?" Only when we can honestly give affirmative answers to both these questions should we begin to become concerned with details of implementation on a local level. We confidently anticipate that students and teachers who will participate in the BSCS course will experience the excitement and thrill of the scientific revolution that is reshaping our modern society. Besides enjoying the satisfaction that comes with acquiring solid knowledge in the life sciences, we hope that they will be able to distinguish between science and superstition and, as citizens, that they will be prepared to act intelligently in the thousand ways in which scientific attitudes are appropriate.

Committee Membership

Steering Committee

- Chairman:** Dr. H. Bentley Glass, Johns Hopkins University, Baltimore, Maryland.
Dr. Paul F. Brandwein, Harcourt, Brace and Company, Inc., New York City.
Dr. Elmer G. Butler, Department of Biology, Princeton University, New Jersey.
Dr. Hiden T. Cox, Executive Director, American Institute of Biological Sciences, Washington, D. C.
Dr. John Emlen, Department of Zoology, University of Wisconsin, Madison.
Dr. Lester Evans, Director, Center for Rehabilitation Services, New York City.
Dr. Wallace O. Fenn, School of Medicine and Dentistry, University of Rochester, New York.
Dr. Angelo Giadrone, Superintendent, Tacoma Public Schools, Washington.
Dr. David R. Goddard, Director of Division of Biology, University of Pennsylvania, Philadelphia.
Dr. Arnold B. Grobman, Director, Biological Sciences Curriculum Study, University of Colorado, Boulder.
Dr. Lewis H. Kleinholz, Division of Mathematics and Natural Science, Reed College, Portland, Oregon.
Mr. Paul Klinge, Coordinator for School Science, Indiana University, Bloomington.
Dr. C. S. Pittendrigh, Department of Biology, Princeton University, New Jersey.
Dr. C. Ladd Prosser, Department of Physiology, University of Illinois, Urbana.
Dr. Alfred S. Romer, Director, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.
Dr. Paul B. Sears, Conservation Program, Yale University, New Haven, Connecticut.
Miss Ella Thea Smith, Cave Creek, Arizona.
Dr. Herman Spieth, Chancellor, Riverside Campus, University of California, Riverside.
Dr. E. C. Stakman, Department of Plant Pathology and Botany, University of Minnesota, St. Paul.
Dr. William C. Steere, Director, New York Botanical Garden, New York City.
Dr. H. Burr Steinbach, Department of Zoology, University of Chicago, Illinois.
Mr. Hugh Templeton, New York State Department of Education, Albany.
Mr. Richard Trump, Ames High School, Iowa.
Dr. H. B. Tukey, Department of Horticulture, Michigan State University, East Lansing.
Dr. Perry Wilson, Department of Bacteriology, University of Wisconsin, Madison.
Dr. Herbert S. Zim, Tavernier, Florida.

Committee on the Content of the Curriculum

- Chairman:** Dr. John A. Moore, Department of Zoology, Columbia University, New York City.
Dr. Harry Alpert, Dean, Graduate School, University of Oregon, Eugene.
Dr. Marston Bates, Department of Zoology, University of Michigan, Ann Arbor.
Dr. Ernst Caspary, Department of Biology, Wesleyan College, Middletown, Connecticut.
Mr. Phillip Fordyce, Oak Park-River Forest High School, Oak Park, Illinois.
Dr. David R. Goddard, Director, Division of Biology, University of Pennsylvania, Philadelphia.
Dr. Jane Oppenheimer, Department of Biology, Bryn Mawr College, Pennsylvania.
Dr. G. Ledyard Stebbins, Department of Genetics, University of California, Davis.
Dr. Delaphine G. R. Wyckoff, Department of Botany, Wellesley College, Massachusetts.

Committee on the Gifted Student

- Chairman:** Dr. Paul F. Brandwein, Harcourt, Brace and Company, Inc., New York City.
Dr. H. B. Goodrich, Shanklin Laboratory of Biology, Wesleyan University, Middletown, Connecticut.
Dr. Anne Roe, Graduate School of Education, Harvard University, Cambridge, Massachusetts.

Committee on Innovations in Laboratory Instruction

- Chairman:** Dr. Addison E. Lee, Department of Botany, University of Texas, Austin.
Mr. Harper Follansbee, Phillips Academy, Andover, Massachusetts.
Dr. H. Bentley Glass, Department of Biology, Johns Hopkins University, Baltimore, Maryland.
Dr. William Jacobs, Department of Biology, Princeton University, New Jersey.
Dr. Florence Moog, Department of Zoology,

Washington University, St. Louis, Missouri.

- Dr. A. Glenn Richards, Department of Entomology and Economic Zoology, University of Minnesota, St. Paul.
Dr. Alfred S. Sussman, Department of Botany, University of Michigan, Ann Arbor.

Committee on Teacher Preparation

- Chairman:** Dr. Joseph J. Schwab, Department of Education, University of Chicago, Illinois.
Mr. Frank Lindsay, California Department of Education, Sacramento.
Dr. Dorothy Matala, Biology Department, Iowa State Teachers College, Cedar Falls.
Dr. Virginia McMurray, Collaborative Research Project, Silver Spring, Maryland.
Brother G. Nicholas, F.S.C., Biology Department, University of Notre Dame, Indiana.
Mr. Hugh Templeton, New York State Department of Education, Albany.

Committee on Publications

- Chairman:** Dr. Hiden T. Cox, Executive Director, American Institute of Biological Sciences, Washington, D. C.
Mr. Richard Aulie, Bloom Township High School, Chicago Heights, Illinois.
Mr. Francis Harwood, Director of Publications, American Institute of Biological Sciences, Washington, D. C.
Dr. Clarence J. Hylander, Department of Biology, Bowdoin College, Brunswick, Maine.
Dr. Albert Wolfson, Department of Biological Sciences, Northwestern University, Evanston, Illinois.
Dr. Herbert S. Zim, Tavernier, Florida.
Dr. Paul DeH. Hurd, Consultant, Biological Sciences Curriculum Study, University of Colorado, Boulder.

To keep the biological community, educators, administrators, and other interested persons informed of its plans and progress, the Biological Sciences Curriculum Study will issue a series of free NEWSLETTERS.

If you would like to be on the mailing list for BSCS NEWSLETTERS, please send your name and address to:

The Biological Sciences
Curriculum Study
University of Colorado
Boulder, Colorado

Staff

- Dr. Arnold B. Grobman, Director, BSCS, University of Colorado, Boulder.
Dr. Walter Auffenberg, Assistant Director, BSCS, University of Colorado, Boulder.
Dr. Paul DeH. Hurd, Consultant, BSCS, University of Colorado, Boulder.
Dr. C. Francis Byers, Consultant, BSCS, Lewis-Clark Normal School, Lewiston, Idaho.
Mr. Richard Barthelemy, Research Associate, Laboratory Committee, BSCS, University of Texas, Austin.
Mr. James Dawson, Research Associate, Laboratory Committee, BSCS, University of Texas, Austin.

**Selling FASTER
than any microscope
in history!**

ZOOM

NEW STEREOZOOM*
MICROSCOPES
BY BAUSCH & LOMB!

Breaking all sales records! Just try one in a free on-the-job demonstration and you'll soon see why... they're the newest step forward to faster and easier 3D work.

EXCLUSIVE NEW OPTICS!

Get StereoZoom... continuously variable power! Just a turn of the knob gives an infinite choice of magnifications throughout the whole stereo range... to 120 \times on some models.



EXCLUSIVE NEW POWER POD DESIGN!

A wholly enclosed optical system in a single unit. Keeps out dust and dirt; eliminates old fashioned nosepieces, annoying image jump and blackout. NEW VERSATILITY, TOO! Your choice of StereoZoom or fixed power in a Power Pod that interchanges among any of the five basic stands.



NEW LOW PRICE!

About $\frac{1}{3}$ lower than previous line.

*Trademark, Bausch & Lomb Optical Co.

BAUSCH & LOMB
SINCE 1853



**BAUSCH & LOMB OPTICAL CO.
78004 Bausch St., Rochester 2, N. Y.**

- Send me new B&L StereoZoom Catalog D-15.
 Schedule a demonstration at my convenience.

Name, Title

Company

Address

City Zone State



The Elementary School Science Reporter

Supervision of Elementary School Science: In-Service Courses

By HAROLD E. TANNENBAUM

Professor of Science Education, State University College of Education, New Paltz, New York

DEFINING the role of the elementary school science supervisor has been a matter of controversy for many years. There have been as many interpretations of the specific functions of the supervisor as there have been supervisors in our schools. When this conglomeration of roles is analyzed, however, a definite pattern of functional areas emerges. Enumerating the major ones, we find:

1. The supervisor serves as a science instructor for the teachers in a school system and, either by himself

or with the help of outside experts, designs and executes in-service programs in science education for the teachers of the system.

2. The supervisor prepares the curriculum for the elementary school science program or else supervises its preparation.
3. The supervisor serves as the guide for the classroom teacher, helping him see his shortcomings and helping him capitalize on his strengths.
4. The supervisor coordinates the science program of a school or of an entire school system so that a unified program of science is carried

After-school classes help currently practicing teachers in both content and teaching methods.



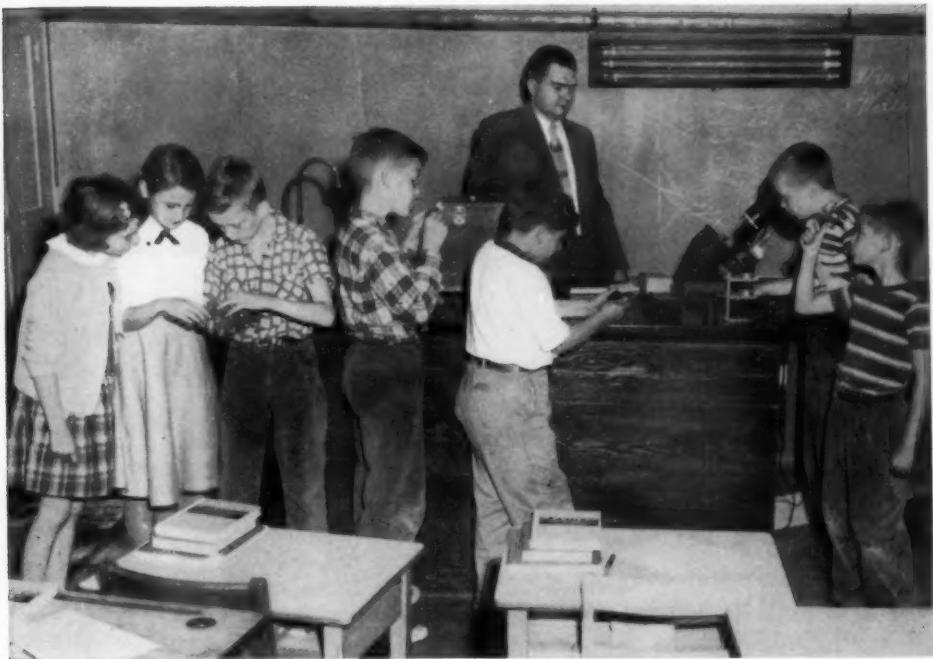
out through the grades and the schools.

5. The supervisor serves as the administrator of the science program, ordering the supplies, coordinating the acquisition of materials, budgeting the funds, and seeing that the materials are properly cared for and distributed.
6. The supervisor evaluates the work of the teachers in the area of science and reports to the employing officials the efficiency of any given teacher.
7. The supervisor serves as a science subject-matter consultant—sometimes for the teacher and sometimes for the children.

Obviously, no one supervisor can perform all of these tasks or fill all of these roles, and each school system has established its own version of the supervisor. But this is all to the good, because different systems have differing needs. A rural county structure will not need the same kind of supervision activities that are required in a comparatively wealthy suburban community. And the functions of supervisors in a large city are quite different from those of supervisors in a town with only five or six elementary schools.

In talking with supervisors from widely scattered geographic regions and various socio-economic communities, the one function which they all feel needs attention is the function of educating currently practicing teachers in both science content and methods of teaching science. The most common procedure followed in fulfilling this need has been the organization of in-service science education courses. At least fifty such courses have come to our attention during the past year, and these fifty are, no doubt, only a small segment of those which have been offered. How have these courses been structured?

While the method of offering each course has varied considerably from one location to another, two general procedures have been followed. Sometimes the supervisor himself has served as teacher of the course. Along with his teachers, he planned, organized, and executed a course in teaching science. School systems all the way from suburban Suffolk County in New York to the Minneapolis city schools to the schools in San Angelo, Texas, have instituted such in-service courses. And there certainly have been others.



Classroom results of in-service programs: new techniques and active student participation.

Another kind of in-service program, while organized by the supervisor in a given community, has been presented by some outside expert, often a college professor. Thus, many extension courses in the teaching of elementary school science have been offered by many universities. And many have been the lectures and one-day workshops which have been sponsored by science supervisors and other school administrators "to bring science into the elementary schools."

Again, taking a census among practicing supervisors, the following opinions have emerged:

The effectiveness of an in-service program has been directly proportional to the duration of the program. A one-day shot has had little effect upon the program. Perhaps it salves the conscience of the administrator—but that is all it does. In-service programs which meet once a week for a semester or a year do make a difference, however.

The more teachers who are actively involved in such programs, the more likely is the effectiveness of the program to be felt in the schools. In large school systems, it has been the practice often to have one or two teachers from each school be the representatives at a system-wide workshop. In such cases, unless these teachers then return to their own schools and organize in-service classes for each school, the effects of the program have been limited.

The size of the in-service classes has been very important. Programs which have been limited to twenty-five students have been much more effective than those which have been established as lectures for larger groups.

The programs that have involved the teachers actively in manipulation and use of science materials have been much more effective than those in which the teachers simply have watched the "expert" demonstrate.

Programs which combine theoretical science and actual experiences with materials and opportunities to discuss effective techniques for teaching science concepts to elementary school children

have been the most effective programs by far.

One thing is clear, however, regardless of what other roles he must play, every elementary school science supervisor must be a teacher of teachers. The variety of techniques which have been employed by school systems for instituting in-service programs has been tremendous. But in all cases, the instructor must not only teach "how to teach science," he must also teach the science itself. A reading supervisor rarely has to teach his teachers how to read. A social studies supervisor generally can spend his time teaching techniques or coordinating programs. But the science supervisor, if he expects his teachers to teach the "science of weather," must first teach this subject matter to the teachers, and then help them learn how to present it to children.

Supervising elementary school science is a tremendous task. Through the columns of "The Elementary School Reporter" we will examine what has been done in various other phases of this work, and report significant programs in forthcoming issues.

We would like to hear from supervisors, teachers, and school administrators from all over the country about the specific successes or failures they have had with science supervisory programs. It is our hope that through such sharing of experiences, some advances can be made in the art of supervision.

Demonstrations can effectively combine theory, experiences, and new opportunities for later presentation.



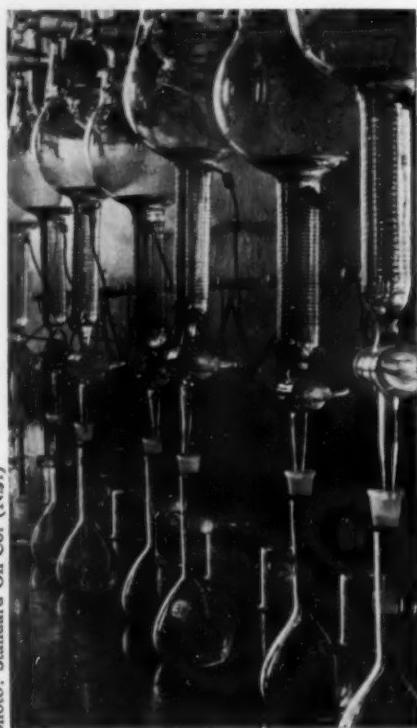


photo: Standard Oil Co. (N.J.)

CHEMISTRY for PROGRESS

by Young and Petty

- Covers essential principles for college preparatory course
- Covers elements through number 101
- Modern methods are used in calculating
- Elements are studied in groups as they appear in the Periodic Table
- Adequate coverage is given to nuclear reactions and carbon compounds
- Balance is maintained between theoretical and applied chemistry
- Questions and exercises are arranged according to difficulty
- Material is written in an interesting style
- Teacher's Manual, key, lab manual, and teacher's key for lab manual are available
- For further information, write to

Educational Book Division
PRENTICE-HALL, Englewood Cliffs, N. J.

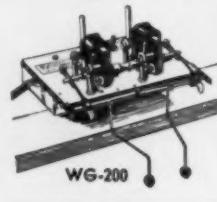
Your students can See wave phenomena with the KINGSTON RIPPLE TANK

PRODUCE WAVES OF VARIABLE FREQUENCY and AMPLITUDE

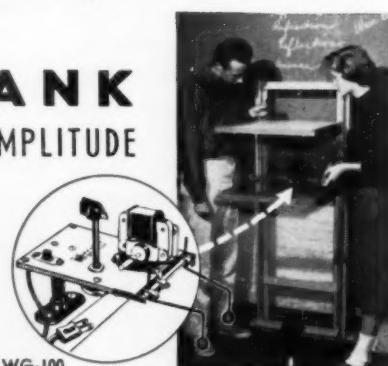
Produces all types of wave phenomena right in your class room. With the fixed phase wave generator (in circle) you can produce plain or radial waves, differing in frequency or amplitude. Designed for student participation, it is easy to set up, completely safe, rugged, flexible and easy to store. Meets all requirements of the PSSC course. Special barriers to show reflection, refraction, diffraction and interference are available as accessories. 115 volt a.c. plug-in eliminates need for batteries.

AVAILABLE NOW! for the FIRST TIME

VARIABLE PHASE WAVE GENERATOR



In addition to waves produced by the RTA-100 described above, the RTA-200 generates 2 radial or 2 plain waves which are out of phase . . . also of different frequencies or different amplitudes.



WG-100

How you may order your apparatus

- RTA-100 Complete fixed phase apparatus . . . \$73.45
- WG-100 Fixed phase wave generator only . . . \$29.75
- RTA-200 Complete variable phase apparatus . . . \$99.70
- WG-200 Variable phase wave generator only . . . \$56.00

f.o.b. Medfield, Mass.

Order now, or write for details on any of the above products

KINGSTON SCIENTIFIC
MEDFIELD, MASSACHUSETTS

NSTA Activities

Chapters and Affiliates

One of the major decisions relating to NSTA's future development and growth will be hammered out by the Board of Directors at Los Angeles next summer. The question is, should NSTA, with the cooperation of appropriate groups, proceed to establish state chapters? Present provision for affiliated group status would be continued for organizations at local, regional, national, and international levels.

NSTA state chapters would *not* compete with present state associations or groups. On the contrary, it would be hoped that these very organizations would serve as NSTA state chapters; most are affiliated with NSTA already.

The major purposes in these considerations are: (1) to develop better definitions of appropriate state and national activities; (2) to strengthen state and national relations and improve the coordination of efforts; and (3) to develop a "stronger voice" for the united science teaching profession. It is rather interesting to note that the stronger, influential departments of NEA do have provisions for state chapters or their equivalent.

The question facing NSTA has been explored with representatives of 22 states in five conference situations. An opinionnaire presenting 17 tentative proposed criteria or principles for a state chapter plan has been submitted also to about 200 persons, including presidents of NSTA's 72 affiliated groups, 25 state supervisors of science, and a sampling of the membership at large.

Replies have been received from 41 per cent (82) of these individuals. Preponderance of opinion on representative items is as follows:

93 per cent believe NSTA should establish state chapters.

72 per cent believe affiliation should be continued for certain non-state groups.

83 per cent say that *existing state organizations* should be encouraged to become state chapters of NSTA.

87 per cent say that *autonomy* of state groups must be assured.

80 per cent favor a "representative assembly" (or similar) plan to afford meetings of delegates of chapters and affiliated groups with NSTA Board of Directors.

47 per cent believe that NSTA should give some form of financial assistance to state chapters.

69 per cent believe NSTA should invite certain associations of science teachers in other countries to affiliate.

The Board of Directors needs and will appreciate advice and viewpoints as they ponder what action to take. Three or four state associations have already requested the honor of receiving State Chapter Charter Number 1. Opposition to the idea has been expressed in strong terms in some instances. Numerous possible pitfalls and devious situations have been flagged. Additional comments and suggestions are solicited. Write your views to the Executive Secretary, or, if you prefer, request a copy of the opinionnaire to mark and return.

Convention, 1961

The dust has hardly settled on the Kansas City convention, yet planning for 1961 in Chicago is well under way. As a matter of fact, President-Elect Robert A. Rice and Convention Chairman Oreon Keeslar pulled their committee together for a first work session in Chicago last November 13-15. The theme and general design for 1961 have been set, and responsibilities for various sessions have been assigned to committee members. Invitations to speakers and other hoped-for participants are to be issued during the coming months.

This is not to say, however, that everything is "cut and dried," that the door to suggestions is closed. On the contrary, speakers you would like to hear, persons you wish to suggest for panels, etc., and the kind of program items you prefer would be helpful to the committee. If you wish to participate, let this too be known. Write directly to Dr. Oreon Keeslar, Santa Clara County Schools, 2320 Moorpark Avenue, San Jose 28, California.

Membership Year

Your membership in the National Science Teachers Association runs for one year from the month payment of dues is received by the Membership Secretary, Mrs. Edith M. Langley. This policy represents a change in the pattern of memberships which was previously based on a December expiration date.

Membership renewals will now be spread over the entire calendar year thus lightening the work load in the headquarters office and providing better services to you. You can make your contribution by renewing your membership promptly upon receipt of your notice. This may be done on a one- or two-year basis; changes in type of memberships may be made at that time.

If questions about your membership payment or services arise, write to the headquarters office bringing the matter to the attention of the Membership Secretary (Mrs. Langley nee Nicholas).

Council for Research

In January the National Science Teachers Association joined with nineteen other professional organizations to form the Council for Research in Education. Continued efforts will be made to enlist the interest of other organizations which can bring an interdisciplinary approach to the study of school and college problems. Currently, many of the departments of the National Education Association are represented together with the American Psychological Association and the American Statistical Association.

The purpose of the Council is to advance the standards of educational research, to improve the preparation of research workers, to distribute information concerning the need for research and the progress of research, and to help research workers find funds for outstanding or needed studies. The Council is not intended to become a research agency. A definitive program will be worked out by the Committee on Research and Review under the chairmanship of Herbert A. Smith, Past President of NSTA.

Officers of the Council include: Kenneth E. Anderson, *Chairman* (representing the National Association for Research in Science Teaching); Boyd Harshbarger, *Vice-Chairman* (representing the American Statistical Association); Frank W. Hubbard, *Secretary* (representing the National Education Association); and John G. Darley, *Treasurer* (representing the American Psychological Association). Other members of the Board of Directors are: Maynard Bemis (representing Phi Delta Kappa); Howard McClusky (representing the Adult Education Association); and Percival M. Symonds (representing the American Educational Research Association).



Buying Blind?

Diamond D Superiority Gives You Top Quality Yet Saves You Money... And You Can Prove It!

No purchasing agent . . . no technical man . . . will buy a pig in a poke! Their approach to the job and the procedures involved make it practically impossible to buy blindly. That's why we offer a simple 2-step evaluation of laboratory glassware to prove that top quality can cost less money. For instance . . .

STEP ONE: Obtain competitive samples of lab glassware, including Diamond D, and subject them all to the most rigid tests you can devise. Rate every brand honestly.

STEP TWO: Check the ratings against the prices for each piece and buy the one which gives you the best value for the least money.

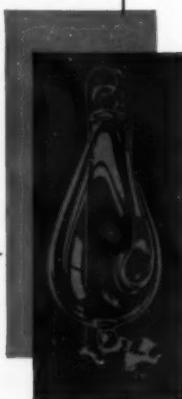
Simple? Certainly, it's simple. That's the way industrial purchasing agents and technical men buy . . . or at least that's how they should buy.

For one of the most interesting studies ever made of the art of glassmaking, send today for your copy

of "Behind The Diamond D." It is a step-by-step picture story of the manufacture of Diamond D Laboratory Glassware. Doerr Glass Company, Vineland, N.J.

OL' NANTUCKET WEATHER GLASS

Here is a hand-blown replica of the weather glasses used on the square-rigged sailing ships that rounded Nantucket Light more than a century ago. It is a crystal-clear pear-shaped pendant which hangs on a 10 $\frac{1}{4}$ " long wrought iron bracket. Fill the glass with water according to directions; chart shows how to translate movement of water in spout in terms of weather forecasts. Ideal for home, office, den, recreation room, college dorm or classroom. \$3.95 postpaid. Doerr Glass Specialties, Inc., Vineland, N.J. Offer good only in continental U.S. and Canada.



**DIAMOND "D"
GLASSWARE**

Quality Begins With Price And Ends With Performance

SAAS, 1960

Winners of the 1960 SAAS contest have been selected and announcements of the final results are in preparation for early distribution.

In each of eleven regions a group of scientists, science educators, and science teachers, acting as judges, have met and evaluated the various projects submitted in the respective regions. These judges get no honorarium, no metals, no plaques. They donate their time and talent because they feel that this is a program that is increasing the "science quotient" of today's secondary school students. This is a contribution meriting attention and appreciation.

The responsibility for organizing and carrying out the program in each region rests with the regional chairman. He, too, donates his time and talent to the program. After the judges have finished their work, the chairman sends the reports, projects, etc., to NSTA headquarters. These chairmen are the SAAS indispensable men. Their reward is in the satisfaction of a job well done as evidenced by the results. Their efforts are sincerely appreciated. Listed below are these eleven regional chairmen.

SAAS Indispensable Men

Region I

Edgar N. Johnson
West Springfield High School
West Springfield, Massachusetts

Region II-A

Samuel W. Bloom
Benjamin Franklin High School
Rochester, New York

Region II-B

David McNeely
Summit High School
Summit, New Jersey

Region III

John B. Chase
University of North Carolina
Chapel Hill, North Carolina

Region IV

Paul L. Guptill
Station WETV
Atlanta 9, Georgia

Region V-A

Leroy Heinlein
Cincinnati Public Schools
Cincinnati, Ohio

Region V-B

Edward Victor
Northwestern University
Evanston, Illinois

Region VI

Michael Foss
Augustana College
Sioux Falls, South Dakota

FSA Activities

Region VII

Alan Humphreys
University of Texas
Austin, Texas

Region VIII-A

John Hutchison
Portland Public Schools
Portland, Oregon

Region VIII-B

Eugene Roberts
Polytechnic High School
San Francisco, California

Roster of Sponsors

The list of sponsors for the 1959-60 FSAF program continues to grow. Since reporting in the February issue of *TST*, these organizations have been added to the roster.

Armco Steel Corporation
The Maytag Company Foundation, Inc.
Raytheon Company
Rohm & Haas Company
Standard Oil Company of New Jersey

Through February 10, 1960 our total member contributors have supported FSAF with a total of \$22,190.

Research Participation

The San Francisco Aquarium Society has generously donated \$3000 to support the FSAF program of on-the-job research experiences for teachers and students. This sum will be allocated to support research proposals submitted to NSTA by California science teachers. If you have a research project which you and your students have not been able to complete for lack of funds—here is your opportunity. Write to NSTA headquarters to get directions for submitting your proposal.

Annual Spring Meeting

On April 29-30, 1960, the FSAF Administrative Committee will hold its annual spring meeting. The first day of this meeting will be open to all sponsors and friends of FSAF who are interested in the program of the Foundation. Discussions will include accomplishments of the year, suggestions for the coming year, industry and the FSAF program, and other topics that are presented.

On the second day, the Administrative Committee will meet to plan the 1960-61 program and to determine the budget needs for the year. You are urged to submit your ideas for FSA activities for consideration of the committee.

FSA Publications

Booklets produced under the sponsorship of the Foundation continue to be among NSTA's best selling publications. It is a safe bet, for example, that *Keys to Careers* must be serving an extremely useful purpose. This bibliography of career information and guidance materials is now in its fifth edition and nearly 200,000 copies have been printed and distributed. (Single copies are available for 10 cents each.)

Approaching the 200,000 mark, also, is the current edition of *Careers in Science Teaching*. (Single copies are available free of charge, and additional copies for 10 cents each.)

About 50,000 students have purchased copies of the FSA publications which give ideas and procedures for doing student science projects. These include *If You Want to Do a Science Project* and *Encouraging Future Scientists: Student Projects*. (Both are available for 50 cents each.) These two booklets may prove stimulating and useful to science-minded students who want to plan a project during the summer months.

Creative Teaching Unlimited

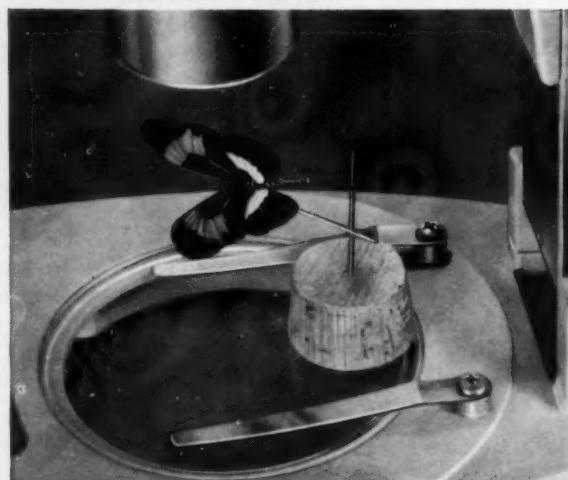
with the AO Spencer Cycloptic Stereoscopic Microscope



Hunt and select individual protozoa with eye dropper



Study living chick embryo during development



See exquisite detail in 3-D



Observe teeming infusoria jungle in 3-D

The AO Spencer CYCLOPTIC Stereoscopic Microscope exposes the student to three-dimensional microscopic worlds beyond the scope of their everyday experiences. Gross specimens, such as fossils, insects, bark, larva, etc., assume new proportions of interest when seen in sharp, erect, magnified three-dimensional detail.

If at all possible, there should be at least one AO CYCLOPTIC in every biology class... set up and readily available for use by all students. Invite them to bring in their own specimens for study and 3-D viewing. The student's interest is aroused... he participates actively... the learning process is quickened.

AO Spencer CYCLOPTIC Stereoscopic Microscopes are built to withstand hard usage by the most active class. Rugged construction guarantees years of service. Special "Permanent" bonding agent assures positive prism alignment. Tough baked, epoxy enamel finish resists chipping, abrasions and chemical deterioration.

The unchallenged superiority of the AO CYCLOPTIC has been time-tested and performance proved... thousands are in daily use in education, research and industry.

Colorful 36 page brochure is yours for the asking, mail handy coupon below.



American Optical
Company

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. D95

Please send SB56 brochure on AO Spencer CYCLOPTIC Stereoscopic Microscope.

Name _____

Address _____

City _____ Zone _____ State _____

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee

Dr. Robert A. Bullington, Chairman
Northern Illinois University, DeKalb

BOOK BRIEFS

The Rock-Hunter's Field Manual. D. K. Fritzen. 207p. \$3.50 Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1959.

For the use of the amateur in the field or at home. Contains a useful key to 126 minerals based primarily on color but also using properties of luster, streak, hardness, and fracture. Includes alphabetical listing of minerals with description and explanation of uses.

Of Things Bi-Illogical. Bernal R. Weimer. 70p. \$2.25. From the author, Bethany, W. Va. 1957.

An entertaining collection of amusing verse, cartoons, anecdotes, and excerpts from students' written work and oral comments, all touching on some phase of biology.

Let There Be Light. Lillian J. Bragdon. 92p. \$2.75. J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pa. 1959.

Covers the many fascinating aspects of lighting from its very beginning with primitive man and into the future. History of lighting is revealed in a simple way.

The Spanish Plateau: The Challenge of a Dry Land. Peter Bickley. 96p. \$2.50. Coward-McCann, Inc., 210 Madison Ave., New York 16, N. Y. 1959.

The story of the difficult life of the people on the arid plateau of Spain. The climate, topography, soils and agriculture, and problems of irrigation are interestingly described for the juvenile reader from 10 to 15. Illustrated with excellent photographs by the author.

Our World of Science. Duane Bradley and Eugene Lord. 160 p. \$3. J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pa. 1959.

Book explains some of the aspects of the physical sciences, such as sound, light, air, water, motion, gravity, heat, electricity, and magnetism. Gives clear explanations of facts underlying these phenomena. Can be used by young boys and girls, as well as by parents.

All About the Ice Age. Patricia Lauber. 152p. \$1.95. Random House, Inc., 457 Madison Ave., New York 22, N. Y. 1959.

Poses interesting questions about the ice age. Includes story of Louis Agassiz's pioneering study of this interesting era as well as the work of modern scientists. Describes origin, movement, and work of glaciers. Life in the ice age, fossils of the period, and carbon dating are explained. Explores possibilities of future periods of glaciation. Illustrated, drawings. Interesting reading for all ages.

Readings in the Literature of Science. William C. and Margaret Dampier. 276p. \$1.50. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1959.

This anthology, long a classic in the history of science, possesses the happy virtue of coherency in the development of science's more important problems: cosmogony, atomic theory, and evolution. The extracts, with these fields, have been selected so as to afford the reader a better understanding of the total scientific process. A desirable addition to either a private or public library.

The Story of Earth Science. Horace G. Richards. 170p. \$3.75. J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pa. 1959.

Written for the layman about rocks, fossils, and minerals. The book has selected the more common examples of the areas treated. These are described and explained with an element of simplicity which invites the continued attention of the lay reader. An elementary basis is laid for further study of each of the items described.

Science and Resources: Prospects and Implications of Technological Advance. Edited by Henry Jarrett. 250p. \$5. Resources for the Future, Inc., The Johns Hopkins University Press, Baltimore 18, Md. 1959.

Contains 18 short essays by authorities in as many fields. The papers were originally delivered to the 1959 Resources for the Future Forum. Major topics treated are genetics, weather modification, mineral exploration, chemical technology, nuclear energy, and the space program. Obviously, the series is neither exhaustive nor comprehensive; but for the areas listed this compendium puts between two covers many facts and ideas otherwise available only from widely scattered sources. True to RFF tradition, both natural and cultural aspects of a development receive attention. RFF has resisted our modern tendency to shake human dignity in a test tube and pour it down the drain!

The Logic of Scientific Discovery. Karl R. Popper. 480p. \$7.50. Basic Books, Inc., 59 Fourth Ave., New York 3, N. Y. 1959.

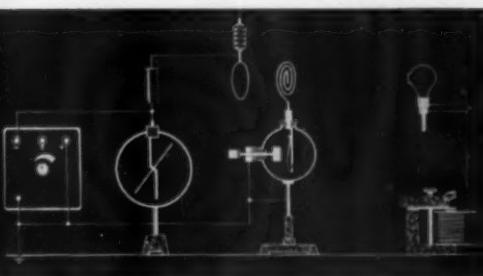
Popper's own translation of his provocative *Lokik der Forschung*, long recognized as an important work in philosophy of science. Contains a most interesting theory of falsification by which the author attempts to bypass the problem of induction. His success at this may be disputed. Discussion of basic statements is original and stimulating but

If you intend to visit Europe . . .

during the summer of 1960, plan to attend Leybold's advanced Physics Laboratory courses for teachers in Cologne, Western Germany. There will be twelve courses given weekly during the summer. The courses are given in English.

For information and reservations, write to:

J. Klinger, 82-87 160th St., Jamaica 32, New York
E. LEYBOLD'S NACHFOLGER
manufacturers of equipment for teaching Physics



LOW-PRICE CLASSROOM AIDS for SCIENCE TEACHERS

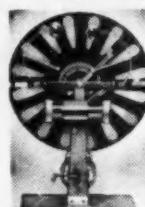
Order by Stock No.—Send Check or M.O.—Money-Back Guarantee . . . Write for FREE CATALOG "AC"

NEW! STATIC ELECTRICITY GENERATOR

Educational and Lots of Fun!

See a thrilling spark display as you set off a miniature bolt of lightning. Absolutely safe and harmless—perfect for classroom experimentation . . . ideal for Science Clubs. Sturdily made—stands 14" high. Turn the handle and two 9" plastic discs rotate in opposite directions. Metal collector brushes pick up the static electricity, store it in the Leyden jar type condenser until discharged by the jumping spark. Countless tricks and experiments. 24-page instruction booklet included.

Stock No. 70,070-AC.....\$12.95 postpaid



BUILD A SOLAR ENERGY FURNACE

Wonderful Science School Project

Build your own Solar Furnace for experimentation—many practical uses. It's easy—inexpensive. Use your scrap wood. We furnish instruction booklet. This sun powered furnace will generate terrific heat—2000° to 3000°. Fuses enamel to metal. Sets paper aflame in seconds. Use our Fresnel Lens—14" diameter . . . f.1 14".

Stock No. 70,130-AC.....Fresnel Lens.....\$6.00 postpaid



D-STIX CONSTRUCTION KITS

Visualize Ideas Fast!

Newest, handiest visualizing and demonstration tool for teachers elementary, high school or college. Colored wood sticks $\frac{1}{4}$ " thick and "easy-on" rubber joints approx. $\frac{3}{16}$ " diam. fit together quickly to form all kinds of simple or complex shapes, structures. Ideal for teaching mathematics, chemistry, physics, design, engineering, architecture, abstract art—or for developing children's interest in form and structure. Work out geometric figures, molecular structures, structural members, configurations and perspectives, models of many types. 3-dimensional visualization adds interest—speeds understanding.

Stock No. 70,209-AC (230 pcs).....\$3.00 ppd.
Stock No. 70,210-AC (370 pcs).....\$5.00 ppd.
Stock No. 70,211-AC (452 pcs).....\$7.00 ppd.



STEREO MICROSCOPE

Over 50% Saving. Up to 3" Working Distance—Erect Image—Wide 3 Dimensional Field. Used for inspections, counting, checking, assembling, dissecting. 2 sets of objectives on rotating turret. Standard pair of wide field 10X Kellner Eyepieces give you 23 power and 40 power. Helical rack and pinion focusing. TEN-DAY TRIAL!

Order Stock No. 85-056-AC.....\$99.50 f.o.b. Barrington, N. J.



LOW-COST VERSATILE SPECTROSCOPE

Ideal for experimental or school uses. Can be used with transmission diffraction grating replica (a piece is supplied) or with prism. It has a rotating prism. It has a rotating prism table with scale. The telescope arm extends through 120°. 10X eyepiece is standard microscope size with reticle. Slit is adjustable. Optical system includes two achromatic 25mm diam. 122 mm f.l. lenses. Arms extend from 5" to 8" for focusing. Diameter of base is 6", overall height 4" and overall width approx. 14". Instructions included.

Stock No. 70,229-AC.....\$39.50 Postpaid

NOTICE: Edmund is now headquarters for Math Learning and Teaching Aids! See dozens of offerings in our FREE Catalog—"AC."

TRIG AND CALCULUS CARDS

Used to clinch the learning of trig identities or calculus formulas. Each deck contains 52 playing cards, plus instruction, and is used to play a game similar to Solitaire. Our decks include Differential Calculus, Integral Calculus, Applied Calculus, and Fundamental Identities from Trig.

Stock No. 40,314-AC—Set of all four decks....\$4.00 Pstd.



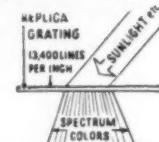
REPLICA GRATING

Take Unusual Color Photos At Night!

After decades of effort, low-cost diffraction grating replica film is available. This film has 13,400 lines per inch. Diffraction Grating has been used to answer more questions about the structure of the material world and the universe than any other single device. Use it for making spectrometers, for experiments, as a fascinating novelty. Cheap enough that you can pass a piece out to each student. Produces beautiful view of spectrum. Comes in clear plastic protector.

Stock No. 50,202-AC—includes 2 pieces 8" x 5½"—

1 transmission type, 1 reflecting type.....\$2.00 Pstd.
 Order by Stock No.—Send Check or M.O. Satisfaction Guaranteed



LOW-COST MICRO-SLIDE PROJECTOR SHOWS EXPERIMENTS ON SCREEN

New way to teach chemistry and science. Project on-the-spot experiments, on screen or wall, with magnification, actually as they progress. Important phases, reactions may be observed by student group in revealing size—perfect vehicle for clear-cut instruction. Projector comes with a 3-element, 80mm focal length f/3.5 anastigmat lens and a fast 28mm focal length, 4-element f/1.2 lens for microslide projection use. Also you get special elevated slide and specimen projection stage; standard 35mm, 2" x 2" slide carrier; 35mm strip film holder. Additional accessories available—water cooled stage; polarizing filters; petri dishes; miniature test tubes and holders; gas absorption apparatus, electrolytic cells and many others.

Stock No. 70,230-AC.....\$45.00 Postpaid
 Separate motor and blower for cooling Projector.

Stock No. 70,263-AC.....\$15.00 Postpaid



LOW FRICTION AIR PUCK

DEMONSTRATES FRICTIONLESS MOTION

This fascinating model will float around on a flat surface on a cushion of air. Just touch it slightly and it will slide frictionlessly across the table, etc. Operates on same principle as Ford's and Curtiss-Wright's new, wheelless air-glide cars. Special balloon provides the air, and base is of strong, flat plastic 6" in diameter.

Stock No. 50,228-AC.....\$2.00 Postpaid
 6" Dia. heavy Chromed Steel Puck—operated by fizz bottle cartridges.
Stock No. 70,185-AC.....\$22.50 Postpaid



RIPPLE TANK

Simplifies Teaching of Wave Motion of Light

One-piece, leak-proof tank is made of optically transparent plastic with a clear water area 20" x 20" . . . 1¼" deep. The rigid wood frame comes in two identical units, the bottom frame receiving the water tank and the upper frame holding a rigid, translucent plastic projection screen. A clear bulb placed beneath the tank provides illumination for projection. Mechanism is actuated by an eccentric fastened directly to the small motor shaft. Wave vibrations are transmitted to the water surface through a leaf spring supported rod, to give parallel wave front or point source agitation with the supplementary attachment which is included. Motor is operated by two flashlight batteries in a brass case with a sturdy rheostat to vary the speed. Order today. Low cost permits purchase in quantity.

Stock No. 85,064-AC.....\$49.50 f.o.b.
(Shipping weight 35 lbs.)
 Barrington, N. J.
 Order by Stock No.—Send Check or M.O. Satisfaction Guaranteed!



FREE CATALOG—AC

128 Pages! Over 1000 Bargains!

America's No. 1 source of supply for low-cost Science Teaching Aids, for experimenters, hobbyists. Complete line of Astronomical Telescope parts and assembled Telescopes. Also huge selection of lenses, prisms, war surplus optical instruments, parts and accessories, math learning and teaching aids. Request Catalog—AC and FREE Bulletin 50-AC (on Science Teaching Aids).

Easy Payment Plan Available! Details With Catalog!



EDMUND SCIENTIFIC CO.
BARRINGTON, NEW JERSEY

THE SCIENCE TEACHER

unfortunately brief at the points of greatest vulnerability. Contains much interesting material on testability, simplicity, probability, and corroboration. Presupposes an acquaintance with formal logic and epistemology.

Human Heredity. Ashley Montagu. 398p. \$5. The World Publishing Company, 2231 West 110 St., Cleveland 2, Ohio. 1959.

A volume readable by the interested high school student and acceptable to the professional. It is a well-considered discussion of the hereditary and environmental determination of human development, treated in the light of modern social and international conditions. Should prove an eye-opener to many biologists.

Brimstone: The Stone That Burns. William Haynes. 308p. \$5.95. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J. 1959.

Brimstone is a book which brings up-to-date the story of sulfur originated in the book entitled *The Stone That Burns*, published in 1942. It brings the story from sulfur resources of the Louisiana swamps through its years of development to the present-day sulfur recovery practices employed in France and Canada. The book is filled with specific facts about places as they are related to the recovery of sulfur today.

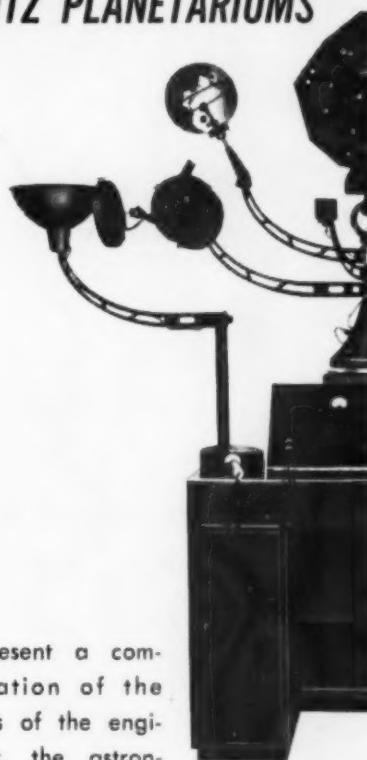
Earth Science: The World We Live In. Second Edition. Samuel N. Namowitz and Donald B. Stone. 614p. \$5.20. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J. 1960.

This is an expanded second edition of a high-ranking text for junior high school courses in the Earth Sciences. Includes an extra chapter on economically important minerals, four chapters on earth history, and several color plates, a complete glossary, and an appendix containing a table of mineral identification properties.

The Education of Teachers: Curriculum Programs. 464p. \$3.50. National Commission on Teacher Education and Professional Standards (TEPS), National Education Association, 1201 16th St., N.W., Washington 6, D.C. 1959.

Proceedings and report of the 1959 TEPS Conference at the University of Kansas, Lawrence, Kansas. The second in a series of three cooperative national conferences, the Kansas Conference was devoted to the changes necessary in teacher education curricula to provide outstanding teachers for the future. Included are the conference and section addresses; summaries, analyses, and recommendations stemming from group discussions; and all of the conference working papers.

SPITZ PLANETARIUMS



represent a combination of the skills of the engineer, the astronomer, and the educator. Space and time, sun, moon, stars, and planets are at the teacher's command in any school which utilizes

a Spitz Planetarium to prepare its students for the age of space.



For information, write DEPARTMENT S

SPITZ LABORATORIES, Inc.

YORKLYN, DELAWARE

GO MODERN IN YOUR SCIENCE TEACHING WITH NEW WARP'S REVIEW-WORKBOOKS

The four SCIENCE REVIEW-WORKBOOKS, although they cost pennies per pupil, (as little as 50 cents per book in lots of 100 or more) will bring new zest and life and lastingness to your 5th, 6th, 7th, and 8th Grade Science classes or they will not cost a penny.

We invite you to try them for ten days. You be the judge. If they don't add something valuable to your classes in the form of heightened interest, retained facts, greater depth and perception, return them—you will not owe us a cent.

So do send today. Send no money. Merely tell us how many Science pupils you teach and in what grades. We will do the rest.

The importance of Science in the world around us makes it a solemn obligation on every teacher's part to teach her pupils Science as effectively as she can.

WARP PUBLISHING COMPANY
MINDEN, NEBRASKA



Send for free brochure of other scientific experimental equipment.

PUMP PLATES

These pump plates are a departure from conventional pump plates in that they are made of light-weight aluminum alloy. A Neoprene pad cemented to the plate permits use of the plate with glass or plastic bell jars, or fruit jars, tumblers, tin cans and other things with irregular edges.

8" x 8" plate for up to 6½" bell jars.....	\$11.00
12" x 12" plate.....	18.00

SAFETY BELL JARS

Safety bell jars are made of heavy wall Lucite plastic. Their construction permits complete safety in use, convenience, light weight, and easy insertion of apparatus.

Construction

The removable tops are ½ and ¾ inch thick Lucite plates with a central hole which fits a No. 3 rubber stopper. A Neoprene rubber gasket between cylinder and plate makes a vacuum tight joint without grease.

MORRIS AND LEE 294 ELM ST., BUFFALO 3, N.Y.

goals, and implementation of a K-12 science program as well as the conclusions of the Institute's participants. A limited number of copies are available from the Board of Education.

"Low Achievement: A Memorandum and Bibliography." Bureau of Curriculum Research, Board of Education of the City of New York, 110 Livingston St., Brooklyn 1, N. Y. March 1960. Objective, evaluative study of low achievement pupils in the public schools. The report defines low achievement and gives a good history of the subject from the 19th century until modern times. Research studies both past and present from all types of schools are included and statistical summaries show that statements are based on fact. A discussion of vocational high schools and an excellent bibliography round out a very informative review of low achievement in pupils. Single copies are available for 35¢ from the Publications Sales Office, Board of Education.

"Selected Bibliography for Curriculum Workers . . . 1960." Association for Supervision and Curriculum Development (ASCD), National Education Association, 1201 16th St., N.W., Washington 6, D.C. 1960. Collection of curriculum references representing the most significant books, pamphlets, monographs, and articles which appeared during 1959. Subject areas include educational foundations; curriculum organization and development; elementary and secondary instruction in language arts, mathematics, science, and social studies; and special areas of instruction and education. Single copies are available for \$1.

"Curriculum Materials 1960." Association for Supervision and Curriculum Development (ASCD), National Education Association, 1201 16th St., N.W., Washington 6, D.C. 1960. Representative listing of curriculum guides currently being produced by school systems, state departments of education, and colleges engaged in teacher education. Includes complete information on securing all bulletins: address, level or grade, availability, date of publication, and price. Single copies are available for 75¢.

"The Role and Training of the Physicist in Industry." By seven selected industrial leaders. *Physics Today*, 13:23. January 1960. This series of seven selected articles is based on addresses given by industrial leaders at an October symposium held by the American Institute of Physics. The participants, representing fields from automobiles to satellites, offer through these articles guidance of value to science teachers who are counseling the students to train in physics for industry.

"Truth in Physics." By Paul F. Schmidt. *American Journal of Physics*, 28:24. January 1960. When can physical law be accepted as true? Is a theory necessary before the truth of a law can be tested? Are the standards that are used for finding truth in physics applicable to the field of philosophy? These are the basic questions around which this article is written. This is a logical, non-mathematical example of the scientific process.

"Careers for Women in the Physical Sciences." Women's Bureau Bulletin 270. U. S. Department of Labor, Washington, D. C.

there is one high school physics text written for the space age

BASIC PHYSICS

by Dr. Alexander Efron, Stuyvesant High School, N.Y.C.

Atom age physics—not Newtonian age physics in keeping with today and tomorrow's needs for instruction in science

Basic Physics is a thoroughly modern text with a new teaching approach offering an enriched course in intermediate physics for high school and junior college students. High school students using Efron's Basic Physics have done exceptionally well in Regents' Examinations.

In addition to the classical subjects, these are some of the vital, modern, up-to-the-minute subjects comprehensively covered in Efron's Basic Physics . . . Does your present text deal adequately with them?

- "Anatomy" of Solids • Surface Energy in Liquids • Heat: Energy in Transit • Temperature: an Energy Level or "Hill". • Graphics of Heat Exchange • Heat Carriers and Heat Transport
- Cryogenics • Pressure: a Scalar Quantity • Extremely High Pressures • Penetration of the Ionosphere • Vacuum Engineering • "Geometry" of Sound • Psychophysics of Sound • Hearing, Speech, and Music • Principle of Least Time in Optics • Directional Light Control • New Theories of Earth's Magnetism • Ferrites and Ferroelectrics • Magnetic and Electostatic Domains • B-H Curve; Hysteresis • Ultrasonics • Oxidation-reduction Processes in Electric Cells • Motor action: Deflection of Electrons in a Magnetic Field • Traveling and Standing Sound Waves • Huygenian Wave-Front Construction • New Derivation of Lens Formula • Dioptric Power • New Language of Illumination • Interference of Waves • "Line", "Area", and "Volume" Light Sources • Composition and Resolution of Vectors by Trigonometry • Exponential Notation (Powers of 10) • Circular Motion: Kinematics and Dynamics • The MKS System of Units • Graphics of Motion • Wind Tunnels and Mach Numbers • Heat-Engine Principles and Schematics • Reaction Engines • Voltage as Work per Unit Charge • Non-Hydraulic Treatment of Current • The Anode-Cathode Controversy • Graphics of Electrical Resistance • Mechanics of Induction • Circuits, Vectors, and Mathematics of Alternating Currents • Polyphase A.C. • Rectifiers • Transistors and Solar Battery • History of Subatomic Particles • Research and Power Reactors • Atomic Submarines • Thermonuclear Reactions • Advanced View of the Atom • Rockets, Missiles, and Satellites

HIGH SCHOOLS WITH THE HIGHEST STANDARDS OF PHYSICS INSTRUCTION HAVE ADOPTED BASIC PHYSICS—HERE ARE JUST A FEW

Milford High School, Milford, Conn. E. O. Smith High School, Storrs, Conn. Suffield Academy, Suffield, Conn. Pompano Beach High School, Pompano Beach, Fla. Palm Beach Jr. College, Lake Worth, Fla. South Broward High School, Hollywood, Fla. West Point Public Schools, West Point, Ga. Austin High School, Chicago, Ill. Community High School, West Chicago, Ill. Monmouth High School, Monmouth, Ill. Francis W. Parker School, Chicago, Ill. West High School, Rockford, Ill. Elkhart High School, Elkhart, Ind. Ames Community School District, Ames, Ia. Hebron Academy, Hebron, Me. Friends School, Baltimore, Md. Board of Education, Baltimore County, Towson, Md. Baintree High School, Baintree, Mass. Longmeadow High School, Longmeadow, Mass. Mendon High School, Mendon, Mass. Military Academy, Milton, Mass. Roxbury Latin School, Roxbury, Mass. Tantasqua Regional School District, Sturbridge, Mass. Noble and Greenough School, Dedham, Mass. Milton Academy, Milton, Mass. Detroit County Day School, Birmingham, Mich. A. B. Davis High School, Mount Vernon, N. Y. Fieldston School, New York, N. Y. Forest Hills H. S., Forest Hills, N. Y. Fulton H. S., Fulton, N. Y. Andrew Jackson H. S., Cambria Heights, N. Y. New York Trade School, New York, N. Y. The Nichols School, Buffalo, N. Y. Peekskill Military Academy, Peekskill, N. Y. Julia Richman High School, New York, N. Y. The Waldon School, N. Y. C. Thomas A. Edison Vocational H. S. (Jamaica), N. Y. Stuyvesant H. S., N. Y. C., and many others.

195, 2 vols. in one cloth binding, 724 pp., 800 illust., \$7.60 list.

BRILLIANTLY CONCEIVED LABORATORY WORKBOOK FOR BASIC PHYSICS.

PHYSICS QUESTIONS & PROBLEMS—with answers by Dr. Alexander Efron.

Lists more than 600 important problems and answers for use in conjunction with BASIC PHYSICS. # 195-3, \$1.50.

Send for review copies on 30-day approval. At end of 30 days you can either remit price of book or return it without cost.

SCHOOL DISCOUNTS APPLY

Dept. ST-4

JOHN F. RIDER PUBLISHER, INC.

116 West 14th Street, New York 11, N.Y.

1959. Because of today's critical need for qualified scientists, careers for women are abundant in such fields as chemistry, physics, geology, astronomy, and meteorology. This report outlines the basic preparation recommended for a scientific career, the job outlook in a few major scientific areas, the kind of work available for qualified women scientists, and the rewards such work offers. Data are also given on the employment, education, types of work, and characteristics of women scientists. Reports are available at 35¢ each through the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

"Analysis of Research in the Teaching of Science July 1956-July 1957." By Ellsworth S. Obourn and Charles L. Koelsche. U.S. Department of Health, Education, and Welfare Bulletin 1960, No. 2, Washington, D. C. Bulletin summarizes and interprets the research findings in science education on the elementary, secondary, and college levels. Studies were related to such topics as science curriculum, teachers and teacher education, procedures, methods and resources, texts and syllabi, and science achievement. Recommendations for all levels are included. Bulletin available for 25¢ each through the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C.

"The Chemical Industry Facts Book 1960-61." Fourth Edition. Manufacturing Chemists' Association, 1825 Connecticut Avenue, N. W., Washington 9, D. C. 1959. Describes

Enrich Science Studies with:
UNDER A GREEN ROOF

By ANNE MARIE JAUSS. Many illustrations by the author. Birds and animals living in our woods. Grades 3-6. \$2.95

WATER OVER THE DAM

By DOROTHY CHILDS HOGNER. Illustrated by Nils Hogner. Dams from earliest days to the present, and how they have affected our lives. Grades 9-12. \$3.95

THE LIVING HOUSE

By GEORGE ORDISH. Illustrated. The inhabitants of a 400-year-old English country house—human, animal, insect and bird—through the centuries. H.S. \$4.50

THE WORLD BENEATH THE CITY

By ROBERT DALEY. Illustrated with photographs. Fascinating account of work that goes on underneath New York City. H.S. \$3.95

AVIATION FROM THE GROUND UP

By JOHN J. FLOHERTY. A new, up-to-the-minute revision. Grades 7-12. \$3.75

OUR WORLD OF SCIENCE

By DUANE BRADLEY and EUGENE LORD. Illustrated by Tiber Tors. Grades 3-6. \$3.00

THE STORY OF EARTH SCIENCE:

Rocks, Fossils and Minerals

By HORACE G. RICHARDS. Illustrated by Arthur Bink and Jonathan Fairbanks. Grades 9 up. \$3.75

Send for free catalogs of books for (1) elementary & junior high, (2) high school.

J. B. LIPPINCOTT COMPANY

E. Washington Sq., Philadelphia 5, Pa.

The Preferred Standard for Over 40 Years!
LABORATORY APRONS AND COATS

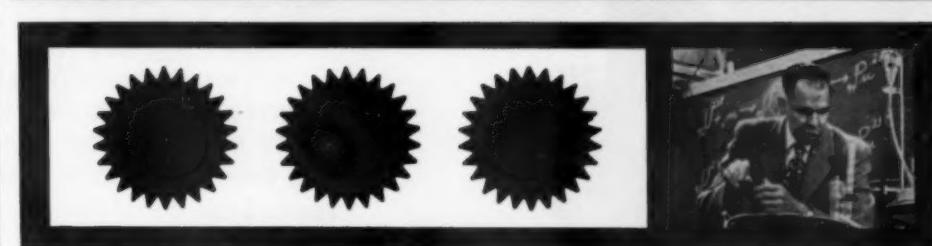


Lab coats in distinctive styles, expert tailoring. Top quality materials. Made especially for lab use. Choice of five colors.

Fine quality aprons at low group prices. Choice of sizes and materials to fit your needs at the price you want to pay.

Send for complete information, including material samples and prices, today.

CAN-PRO Corporation
Subsidiary of the J. M. Nash Co., Inc.
40 E. McWilliams St.
Fond du Lac, Wis.



An Opportunity to Bring a Nobel Prize-Winning Scientist Into Your Classroom . . .

Your students can now see and hear Dr. Glenn T. Seaborg and his associates as they describe the dramatic discoveries of missing and transuranium elements in a series of three FILMS entitled **THE ELEMENTS**.

**Titles In The Series*

MODERN ALCHEMY / Dr. Seaborg describes the isolation and identification of the four "missing elements," francium, technetium, astatine, and promethium.

BEYOND URANIUM / Dr. Seaborg outlines the discovery of the first six elements beyond uranium.

MAKING ELEMENTS / The scientists who participated in the discovery of elements 99, 100, and 101 describe and demonstrate the techniques, equipment, and chemistry associated with the original isolation of these elements.

EACH FILM—16mm / 30 minutes / B&W / \$125

*These films qualify for purchase under Title III of the National Defense Education Act.

Send For Free Information!

Preview Prints Available

NET Film Service
Indiana University
Bloomington, Indiana
Please send information about

THE ELEMENTS films to:

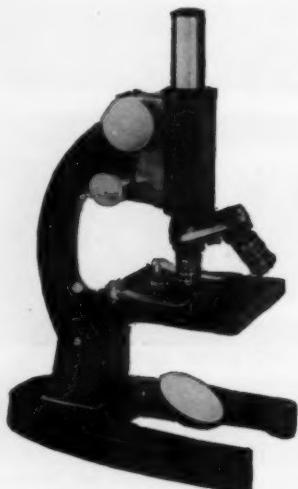
Name _____

Organization _____

Address _____

City _____ Zone _____ State _____





Model GB2A

THE ORIGINAL "SAFETY FEATURE" MICROSCOPE

\$105.30 EACH
in quantities of 5 or more
\$117.00 EACH LIST PRICE

Graf-Apsco

STUDENT MICROSCOPE

MODEL GB2A (WITH CONCAVE MIRROR)

ALL METAL CONSTRUCTION
INDEPENDENT FINE ADJUSTMENT (NOT ONE THAT ACTS ON THE COARSE ADJUSTMENT)
FIRST QUALITY MEDICAL OPTICS
16mm OBJECTIVE (10X) N.A. 0.27
4mm OBJECTIVE (44X) N.A. 0.66
10X HUYGHENIAN OCULAR
ELONGATED BASE TO PROTECT OBJECTIVES
SAFETY MOUNTING OF MIRROR
DISC DIAPHRAGM LIGHT CONTROL
Lower price \$117.00
In quantities of 5 or more Each 105.30
TEN YEAR GUARANTEE TRANSPORTATION INCLUDED
Or with substage illuminator instead of mirror.....Same price

THE GRAF-APSCO COMPANY

5868 Broadway

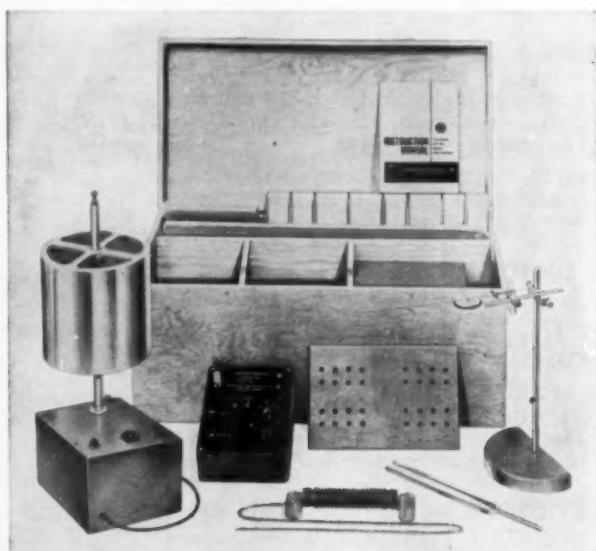
Chicago 40, Ill.

TEACHING KITS FOR STUDENT PHYSIOLOGY EXPERIMENTS

Many physiological phenomena can be translated into motion. In order to best demonstrate these phenomena in the classroom, it is possible to make a continuous and permanent record of this motion which can be discussed during and after the experiment. The Harvard Apparatus Teaching Kits are built around a recording device. In the case of the standard Kit #1000, the device is an electric kymograph, one of the simplest recording instruments to operate and maintain. It produces a wide range of recording speeds and is useful in the majority of experiments. Also available are many levers which will show and record motions of all kinds, such as the contraction of frog muscle resulting from electrical stimuli. The induction stimulator provides electrical stimuli and time marking signals. Human as well as animal phenomena can be shown. For example, the pneumograph demonstrates breathing patterns, and the plethysmograph can be used to show the volume pulse.

Special kits containing equipment and supplies other than those listed for the standard Kit #1000 can be made to order. In all cases, the cost will be a total of list prices. We invite you to send for our Catalog 1959-60 and new price list which contain our complete line of recording instruments and accessories, circulation and respiration equipment, electrical equipment, clamps, stands, rods and various animal accessories. Also available on request is a detailed data sheet listing the contents of the standard Kit #1000 plus a range of auxiliary equipment.

Harvard Apparatus Company, Inc., a non-profit organization, seeks to promote better science teaching through the manufacture of superior physiological apparatus made available at the lowest possible cost. All apparatus is of the highest quality and will give years of continuous service.



CONTENTS OF THE STANDARD KIT #1000 (illustrated)

Electric Kymograph	Plethysmograph Tube
Kymograph Paper	Pneumograph
Induction Stimulator	Clamps
Flat Base Stand	Colophonium Cement
Muscle and Heart Levers	27mm. Signal Magnet
Small Scale Pan	Frog Board (with clips)
10g. Weights	Tuning Fork and Starter
Marey Tambour	Stylus
Silver Electrode	Fitted Case, 24" x 12" x 12"
	\$198.00—f.o.b. Dover, Mass.



HARVARD APPARATUS CO., INC. • Dover, Mass., U. S. A.

(a non-profit organization)

the chemical industry in the United States and how it operates, chemicals in everyday life, and chemicals in the service of man. The future of the scientific world, especially the chapters devoted to "Chemicals and Nuclear Energy" and "Chemicals and Space," are of special interest to teachers and pupils. A comprehensive teachers' guide, prepared by Donald G. Decker and John A. Beel, accompanies the "Facts Book." Copies are available at \$1.25 each through the Manufacturing Chemists' Association.

"The Arms of the Galaxy." By Bart J. Bok. *Scientific American*, 201:93. December 1959. Discusses the experimental work that is being carried on to test the hypothesis that our galaxy is a giant spiral. Diagram and pictures make the article very valuable.

AUDIO-VISUAL AIDS

Reproduction in Plants. A survey of asexual and sexual plant reproduction for high school use. Includes reproduction in some algae and in lilies, cross fertilization, and vegetative propagation. Best used as a review of basic processes. 13½ min. Color \$137.50, B&W \$75. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.



As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST's* calendar editor as early as possible.

June 29, 1960: NSTA Annual Summer Meeting with National Education Association, Los Angeles, California; Luncheon meeting and afternoon session

June 29-July 1, 1960: Annual Business Meeting of Board of Directors, Los Angeles, California

September 9-10, 1960: NSTA Regional Conference, University of North Carolina, Chapel Hill

October 28-30, 1960: NSTA Regional Conference, Deauville Hotel, Miami Beach, Florida

December 26-30, 1960: NSTA Annual Winter Meeting with the American Association for the Advancement of Science, New York City.

Heart, Lungs and Circulation. For such a broad topic, this film covers a surprising amount of information. The graphic work is clever and lifelike, with paints used on a boy to show circulatory routes. Dialogue excellent. Color recommended for full effect. Suitable for middle and upper grades. 11 min. Color \$110, B&W \$60. 1959. Coronet Films, Coronet Building, Chicago 1, Ill.

Flowers and Plant Reproduction. A color filmstrip which uses labelled drawings to show flower structure, pollination, fertilization, and development of seed and fruit. Useful aid in junior and senior high science. User should be aware of some minor inaccuracies. 31 frames. \$6. 1959. Kapin

Educational Productions, 5843 Cedros Ave., Van Nuys, Calif.

Science Seminar. Originally shown on television, this film was made to explain the "Berg Plan for the Advancement of Science." Shows the plan in operation in the Gary, Indiana, schools. The purpose of the program is the education of science-talented youth through the volunteer efforts of scientists from business, industry, and universities. Film is available to any school or community group interested in the development of special science programs for high school students. 25 min. Free. The Joe Berg Foundation, 1712 South Michigan Ave., Chicago 16, Ill.

*Life-Size •
Authentic • Low-Cost*

PLASTIC TEACHING AID

This faithfully reproduced plastic skeleton has true bone color, texture and appearance. Fully articulated, with soft, vinyl plastic intervertebral discs. Muscle origins in red and insertions in blue painted and labeled on one side for easy reference. Invaluable as teaching aid.

Reproduction is complete in every detail, thoroughly checked by major anatomists. Models can be handled freely — unbreakable in normal use. Should any part get broken or lost, repair or replacement is available at low cost. May be marked on with ink or crayon, and easily erased with soap and water. Never become greasy or offensive. Used extensively by leading schools and universities throughout America.

Write for complete catalog of MPL anatomical models, including skulls, skeletons, heart and parts. Priced from \$18 up.

*Request your model
through Title III of National
Defense Education Act*



Life-size model SK-25
muscle skeleton \$295.00
complete

**MEDICAL PLASTICS
LABORATORY**
DEPT-BT, GATESVILLE, TEXAS

GOOD TOOLS COMPLEMENT GOOD TEACHING!



MODEL E-200C
Multi-Band
Signal-Marking Generator
Net Price: \$99.95



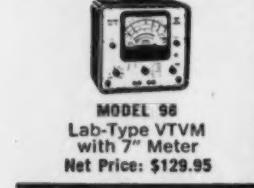
MODEL E-400
Sweep Signal Generator
Net Price: \$175.00



MODEL ES-550B
High-Sensitivity Wide-
Band 5" Oscilloscope
Net Price: \$249.95



MODEL 120
Lab-Type VOM
with Mirrored-Scale
Net Price: \$44.95



MODEL 98
Lab-Type VTVM
with 7" Meter
Net Price: \$129.95



MODEL E-420
Dot and Bar Generator
Net Price: \$159.95



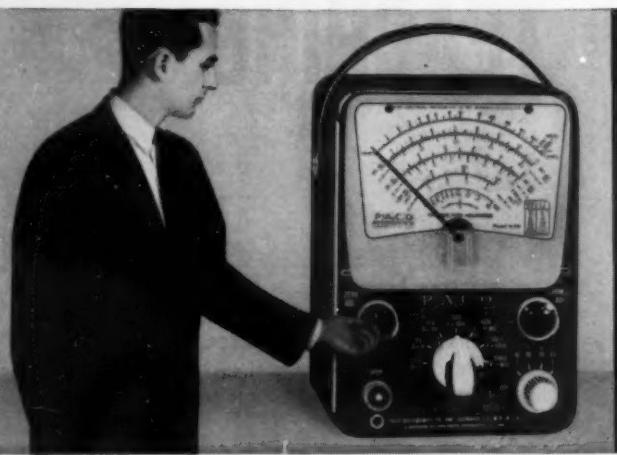
MODEL E-440
Color Bar Generator
Net Price: \$239.95



MODEL 10-60
Electronicamic®
Tube & Transistor Tester
Net Price: \$215.00

That's why **PRECISION**
Test Instruments
and **PACO** Kits
are preferred by
electronics instructors at
every curriculum level!

The nation's schools have learned, over the past quarter-century, that they can depend upon **PRECISION** equipment for quality, flexibility and durability. Whether it's a single instrument, or a complete test bench... you can rely on **PRECISION** for outstanding value, highest engineering standards and maximum protection against obsolescence. Of course, all **PRECISION** test equipment carries a full year guarantee.



THE PACO VTVM CLASSROOM DEMONSTRATOR
designed by ELECTRONICS INSTRUCTORS for ELECTRONICS INSTRUCTORS
Manufactured by **PACO** (the Kit Division of **PRECISION** Apparatus Company, Inc.) this giant-size Classroom Demonstrator features rotating Ohms-Adjust knob, Zero-Adjust knob and a true-to-life moving Meter Pointer. Rugged, processed in 5 colors, this invaluable teaching aid is complete with chain for wall or blackboard mounting. Net Price: \$15

PACO ELECTRONICS INSTRUMENT KITS

The only complete line of electronic equipment in kit form produced by a leading manufacturer of electronic test equipment. **PRECISION**'s reputation for excellence in electronics is your assurance of **PACO** superior performance and value. Ideal for student term projects, each **PACO** Kit is supplied with specially-prepared step-by-step assembly operating manual and giant-size wiring diagrams.

PRECISION Apparatus Company, Inc., 70-31 84th Street, Glendale 27, L. I., New York

Please send me the following:

- Latest free catalog of the entire Precision Test Instruments line
- Free detailed fact sheet on the **PACO** VTVM Classroom Demonstrator
- Latest free catalog of **PACO** Kits
- Free 10 page article by Paul B. Zbar — School Shop Facilities
- VTVM Classroom Demonstrator(s) at \$15 ppd.
I enclose check money order

NAME and TITLE _____

SCHOOL _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

My Electronic Parts Distributor is _____

Index of Advertisers

Albert Teachers' Agency	26
American Optical Company	56
Bausch & Lomb Optical Company	49
Bell Telephone Laboratories	24
Buck Engineering Company, Inc.	33
Cambosco Scientific Company	1
Can-Pro Corporation	61
Central Scientific Company	26, 36, 39
Clay-Adams, Inc.	Cover III
Corning Glass Works	30
Doerr Glass Company	54
E. P. Dutton & Company, Inc.	35
Edmund Scientific Company	58
Fisk Teachers Agency	40
The Graf-Apsco Company	62
Harcourt, Brace and Company, Inc.	Cover II
Harvard Apparatus Company, Inc.	62
Indiana University NET Film Service	61
Kingston Scientific	52
J. Klinger Scientific Apparatus	57
E. Leitz, Inc.	34
J. B. Lippincott Company	61
Medical Plastics Laboratory	63
Morris & Lee	60
McGraw-Hill Book Company, Inc.	38
Ohaus Scale Corporation	Cover IV
Precision Apparatus Company, Inc.	64
Prentice-Hall, Inc.	5, 52
Product Design Company	22
John F. Rider Publisher, Inc.	60
Row, Peterson and Company	32
Science Associates, Inc.	27
Spitz Laboratories, Inc.	59
Swift Instruments, Inc.	4
Testa Manufacturing Company	28
Turner Corporation	39
Unitron Instrument Division, United Scientific Company	12-13, 36
D. Van Nostrand Company, Inc.	40
Warp Publishing Company	59
Franklin Watts, Inc.	23
W. M. Welch Scientific Company	2
Wilkins-Anderson Company	37



Newton had his falling apple

In scientific achievement, chance sometimes plays a role but the teaching of science always requires predictable results . . . reliable tools . . . stimulating aids. Clay-Adams educational materials leave little to chance.

Clay-Adams offers a large selection of science equipment — for laboratory and classroom — including many items for your equipment programs under Title III of the National Defense Education Act. The Clay-Adams line is the result of more than 40 years' experience in the perfection of scientific teaching material. Each of its products — there are more than 1000 — bears the stamp of authenticity and durability. Those for use in the secondary school are detailed in the Clay-Adams "Buyer's Guide for Science Teaching," already mailed to all science departments. Check the Guide — to facilitate your purchases under Title III. Use it — to order quality materials designed to provoke greater student experience, expanded laboratory experimentation — for gratifying science instruction.

In Science Teaching...
Trusted Tools for
Learning and Doing

Clay-Adams

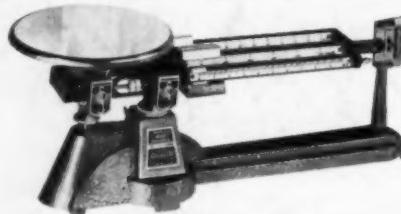
New York 10, N. Y.



HARVARD TRIP BALANCE

Model No. 1550-S

Capacity 2 Kilogram
Sensitivity 0.1 Gram



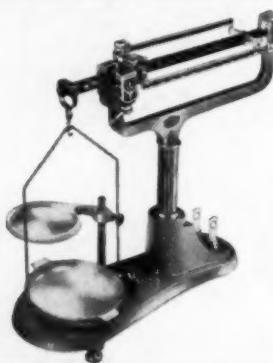
Purchase
Guide No.
0260

list price
\$24.00

TRIPLE BEAM BALANCE

Model No. 750-S

Capacity 2610 Gram
Sensitivity 0.1 Gram



Purchase
Guide No.
0255

list price
\$31.00

CENT-O-GRAM TRIPLE BEAM BALANCE

Model C.G. 311

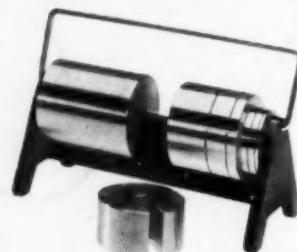
Capacity 311 Gram
Sensitivity 0.01 Gram



STO-A-WEIGH WEIGHT SETS

Available in Class C, Q, or P Adjustment.
Shrinkproof box with Stainless Steel Forceps.

list price
\$4.25 Model 5210.... 50 Gram x 10 Mg....Class C
\$5.00 Model 5211....100 Gram x 10 Mg....Class C



BRASS SLOTTED WEIGHT SET

Model No. 43503

500 Gram x 10 Gram with Weight Rack

WEIGHT HANGER

Model 46207 50 Gram

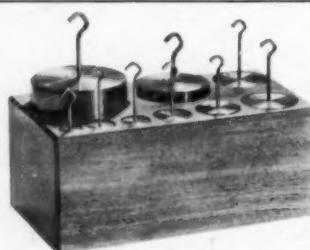
Purchase Guide
No. 4725

Purchase Guide
No. 4685

list price
\$9.50

list price
\$1.00

Purchase
Guide No.
4715



METRIC HOOK WEIGHT SET

Model 46206

1000 Gram x 10 Gram

Lacquered Brass Weights in Hardwood
Block

A COMPLETE LINE OF
balances and weights for the
School Science Program

for complete information write for FREE bulletin

OHAUS
SCALE CORPORATION
1050 COMMERCE AVE.
UNION, NEW JERSEY